Hampshire Water Transfer and Water Recycling Project

Environmental Statement – Appendix 14.2 Detailed unexploded ordnance risk assessment

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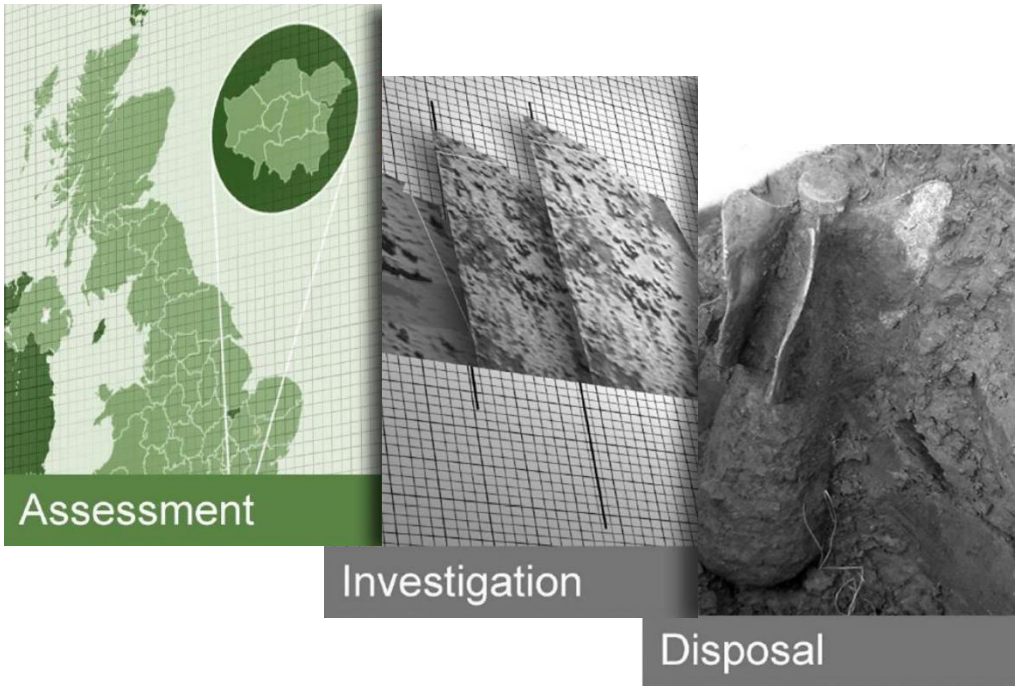
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Version 0

from Southern Water



Budds Farm WTW - UXO Desk Study & Risk Assessment

Document Title	**UXO Desk Study & Risk Assessment**
Document Ref.	**P11650-22-R1**
Revision	**A**
Project Location	**Budds Farm WTW**
Client	**Southern Water**
Date	**6th April 2022**

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UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: Potential hazard from Unexploded Bombs (UXB) on parts of the Site occupied by mudflats and water during World War Two (WWII).

Key actions: Explosive Ordnance Clearance (EOC) engineer supervision for excavations disturbing the WWII land surface in the moderate UXO hazard zone.

To clear borehole or pile locations in these areas, deep UXB detection is required.

UXO Hazard Assessment

Records have been found indicating that at least 300No. High Explosive (HE) bombs fell in Langstone Harbour, in the vicinity of the Site, during heavy air raids in WWII.

It is considered possible that UXBs falling on parts of the Site comprising and mudflats and water may have been missed and not retrieved. These parts of the Site are assigned a moderate UXO hazard level.

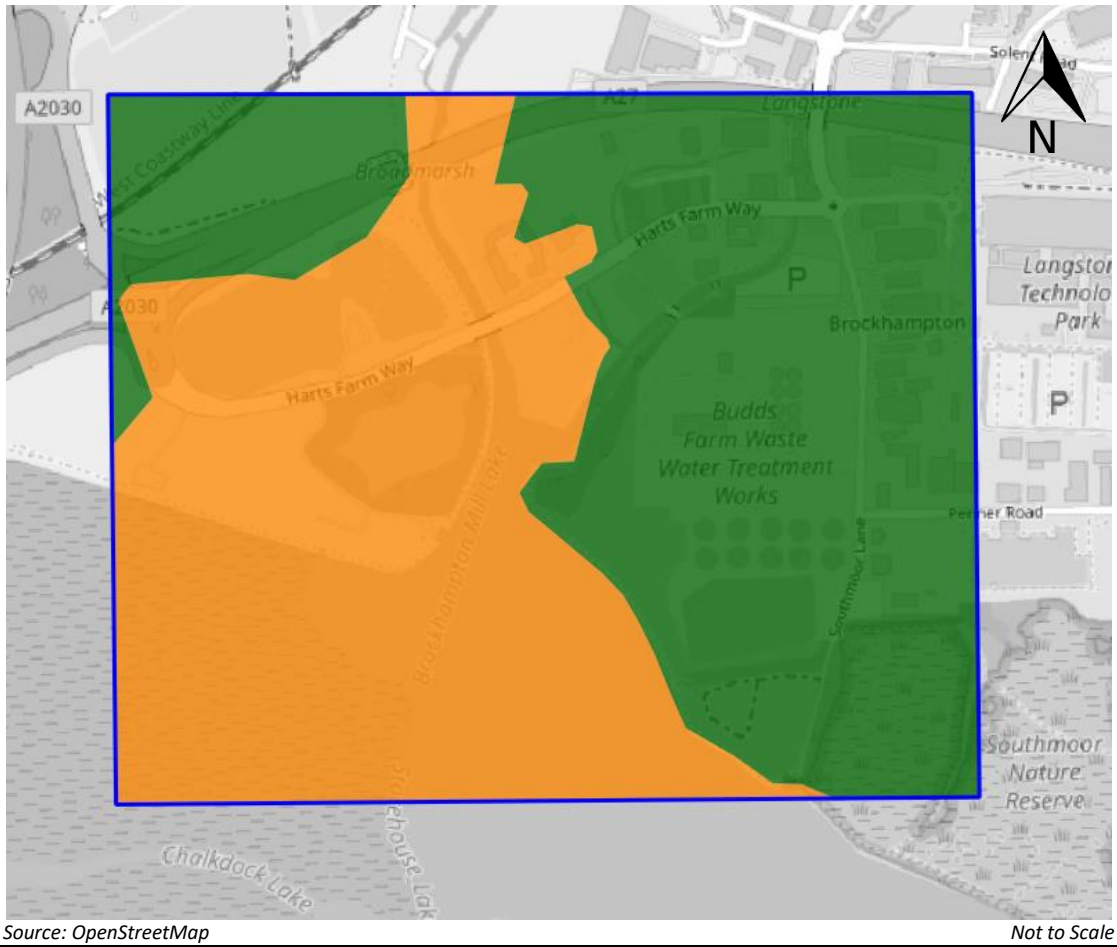
No evidence of significant bombing or other military activity has been identified on the remainder of the Site, which mainly comprised agricultural fields. These areas are assigned a low UXO hazard level.

It is considered that the UXO hazard level on the Site can be zoned from low to moderate, as shown in the figure below, reproduced as Figure 6 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P11650-22-R1-MAP01-A.

It should be noted that significant land reclamation has occurred on parts of the Site assigned a moderate UXO hazard level. The UXO hazard level can be reduced to low within the depth and extents of the post-WWII fill material, which is assumed not to contain UXO.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

The main findings of the report are summarised below.

- No records of bombing or military activity on the Site during World War One (WWI) have been found.
- During WWII the main strategic targets in the vicinity of the Site included military barracks, naval establishments, aircraft manufacturing works and testing airfields, major transport infrastructure and public utilities.
- Records have been found indicating that at least 2No. HE bombs fell on the Site during WWII and more than 300No. bombs fell in the vicinity of the Site.
- Estimated average maximum bomb penetration depths on the Site range from 4.0m to 14.0m depending on the weight of the bomb.
- No records of military activity on the Site post-WWII have been found.

Data Confidence Level

The findings of this report were based on good corroborative evidence of the military activity and bombing on the Site.

Proposed Works

It is understood that initial works on the Site will comprise ground investigations, including trial pits and boreholes.

Future works on the Site will be associated with water treatment works (WTW) renewal services and may include further intrusive ground investigations, excavations, and piling.

It is understood that at present no intrusive works are expected to be undertaken in the waters of Langstone Harbour.

Risk Assessment

The Table below, reproduced as Table 6 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the methodology for the risk assessment are provided in Section 7.2 of the main report.

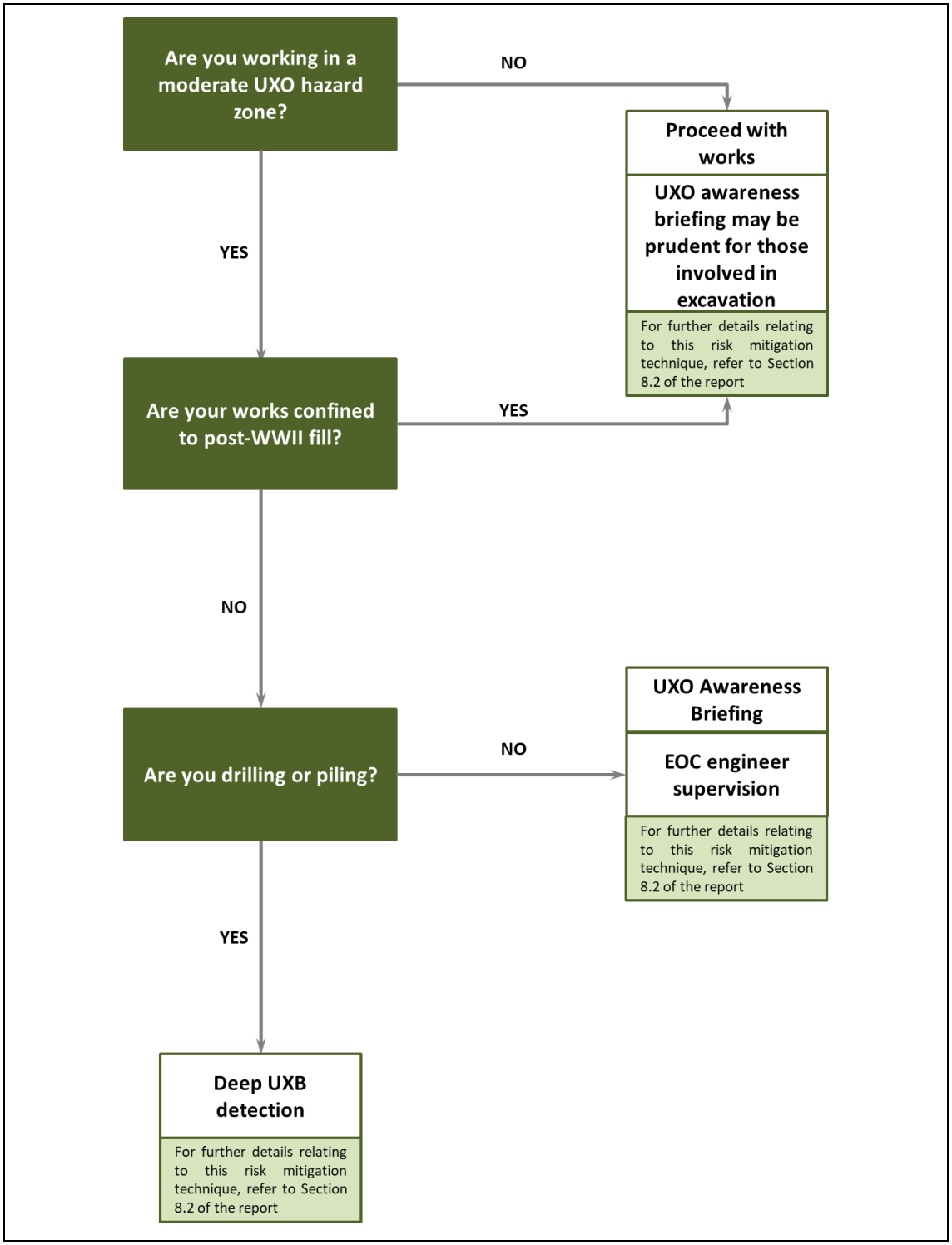
UXO risk assessment for the Site

Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Moderate	UXB	Excavations in post-WWII fill	1	1	1	1	5	5	Low
		Excavations below post-WWII fill	3	2	6	3	5	15	Moderate
		Boreholes/Piling	2	3	6	3	4	12	Moderate
	Other UXO	Excavations in post-WWII fill	1	1	1	1	4	4	Low
		Excavations below post-WWII fill	1	1	1	1	4	4	Low
		Boreholes/Piling	1	1	1	1	3	3	Low
Low	UXB	Excavations in post-WWII fill	1	1	1	1	5	5	Low
		Excavations below post-WWII fill	1	1	1	1	5	5	Low
		Boreholes/Piling	1	1	1	1	4	4	Low
	Other UXO	Excavations in post-WWII fill	1	1	1	1	4	4	Low
		Excavations below post-WWII fill	1	1	1	1	4	4	Low
		Boreholes/Piling	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)									

Risk Mitigation Plan

The Figure below, reproduced as Figure 7 in the main report, provides a risk mitigation plan to ensure that the UXO risk for the proposed works is reduced to As Low As Reasonably Practicable (ALARP).

Recommended risk mitigation plan for the Site



Further details on the recommended risk mitigation techniques are given in Section 8.2 of this report.

The Table below, reproduced as Table 7 in the main report, summarises the UXO risk for proposed works on the Site and recommended techniques to mitigate the risk.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – if additional comfort is required to address the residual UXO hazard, a formal UXO awareness briefing can be provided.
Boreholes/Piling		**Proceed with works**
Excavations		**EOC Engineer Supervision** – to ensure safety and minimise delays, Explosive Ordnance Clearance (EOC) Engineer supervision is recommended.
Boreholes/Piling		**Deep UXB detection –** to clear borehole and pile locations of potential UXB, an intrusive magnetometer survey should be undertaken until either the maximum bomb penetration or maximum drilling/piling depth is reached.

In summary, if works in the moderate UXO hazard zone cannot be confined to post-WWII fill material, an EOC Engineer should supervise excavation works and deep UXB detection should be undertaken at borehole and pile locations.

What Do I Do Next?

If you wish to proceed with UXO risk mitigation, Zetica would be happy to assist. Just contact us via phone (01993 886682) or email ([redacted] and we can provide a proposal with options and prices.

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS Data

P11650-22-R1-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
ARP	Air Raid Precaution
AtA	Air-to-Air
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
BDU	Bomb Disposal Unit
CMD	Conventional Munitions Disposal
DAB	Delayed Action Bomb
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FAA	Fleet Air Arm
FFE	Free From Explosives
HAA	Heavy Anti-Aircraft
HE	High Explosive
HSE	Health and Safety Executive
IB	Incendiary Bomb
IED	Improvised Explosive Device
IEDD	Improvised Explosive Device Disposal
JSEODOC	Joint Services EOD Operations Centre
KBB	Kite Balloon Base
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
PUCA	Pick Up and Carry Away
RA	Royal Artillery
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
ROC	Royal Observers Corps
TEP	Time Expired Pyrotechnics
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXIB	Unexploded Incendiary Bomb
UXO	Unexploded Ordnance
WWI	World War One
WWII	World War Two

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background are paragraphs that provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background are paragraphs providing general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project Outline

Zetica Ltd was commissioned by Southern Water to carry out an Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an area of approximately 143 hectares (ha) at Budds Farm water treatment works (WTW) and Langstone Harbour in Havant, Hampshire ('the Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of Information

Zetica Ltd researched the military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd Defence Related Site Records

Zetica Ltd's in-house records were consulted, including reference books and archived materials from past work in the region. Relevant documents have been cited within the bibliography of this report.

1.2.2 Zetica Ltd Bombing Density Records and Maps

Reference has been made to the Zetica Ltd bomb risk maps located on Zetica's website (http://[redacted]downloads-and-resources/risk-maps/)

1.2.3 Ministry of Defence and Government Records

Government departments and units within the Ministry of Defence (MoD) were approached for information of past and present military activity in the area. These included the Department of Communities and Local Government (DCLG) records of abandoned bombs.

1.2.4 Other Historical Records, Maps and Drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England and the Defence of Britain Project.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.5 Local Authority Records

Information was obtained from Hampshire County Council and Havant Borough Council.

1.2.6 Local Record Offices and Libraries

The Hampshire Record Office was consulted for records.

1.2.7 Local Historical and Other Groups

Local history groups and archaeological societies were consulted, including the Hampshire Historic Environment Record (HER).

1.3 Data Confidence Level

In general, there is a high level of confidence in the researched information sources used for this report. Exceptions to this are specifically detailed in the text of the report.

2 THE SITE

2.1 Site Location

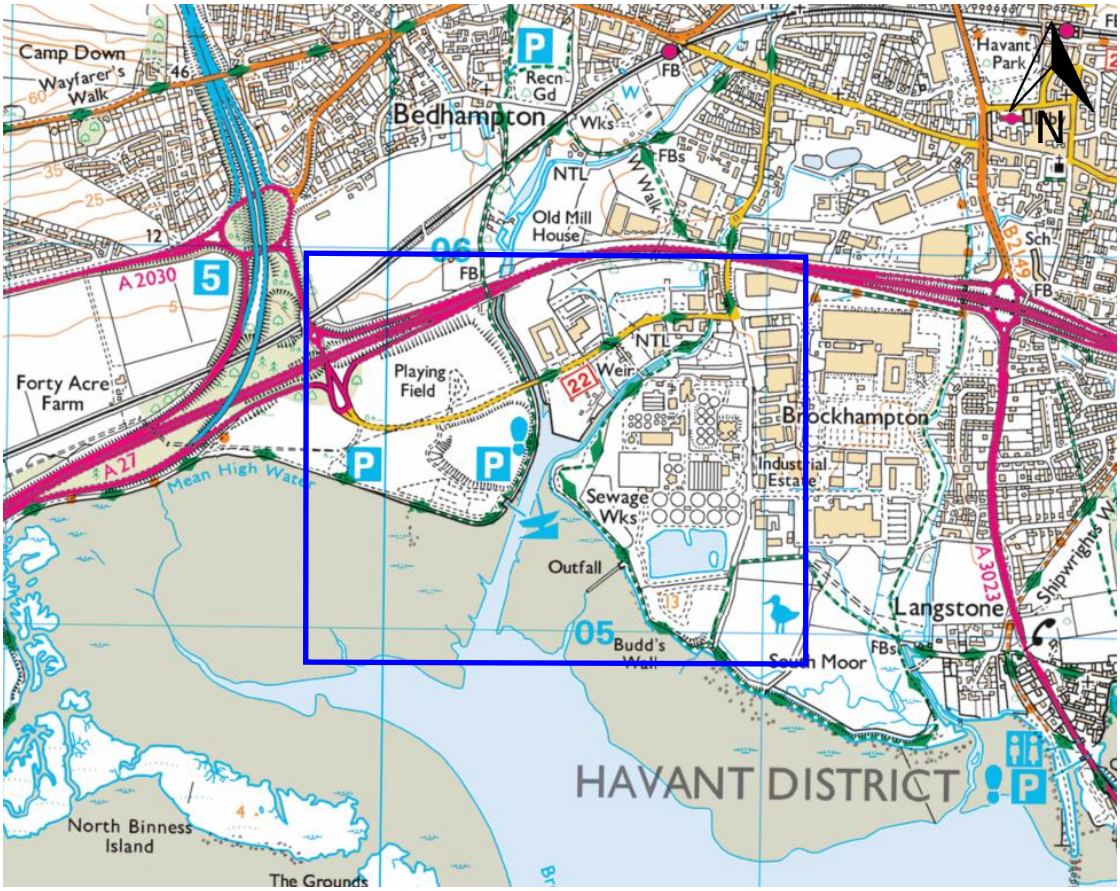
The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU 704053. It is located approximately 7km northeast of Portsmouth city centre.

The Site comprises buildings and facilities associated with Budds Farm WTW, Bedhampton Industrial Estate, hardstanding, open ground, and water and mudflats of Langstone Harbour.

It is bounded to the north and east by open ground and commercial properties, and to the south and west by Langstone Harbour and open ground.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2022. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from World War One (WWI) and World War Two ([redacted] is detailed in Section 4.

Each sub-section provides hyperlinks to further information on potential sources of UXO hazard. These are also available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

3.1 Defences

For further information on military defences, and the potential UXO hazards associated with them, [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]s

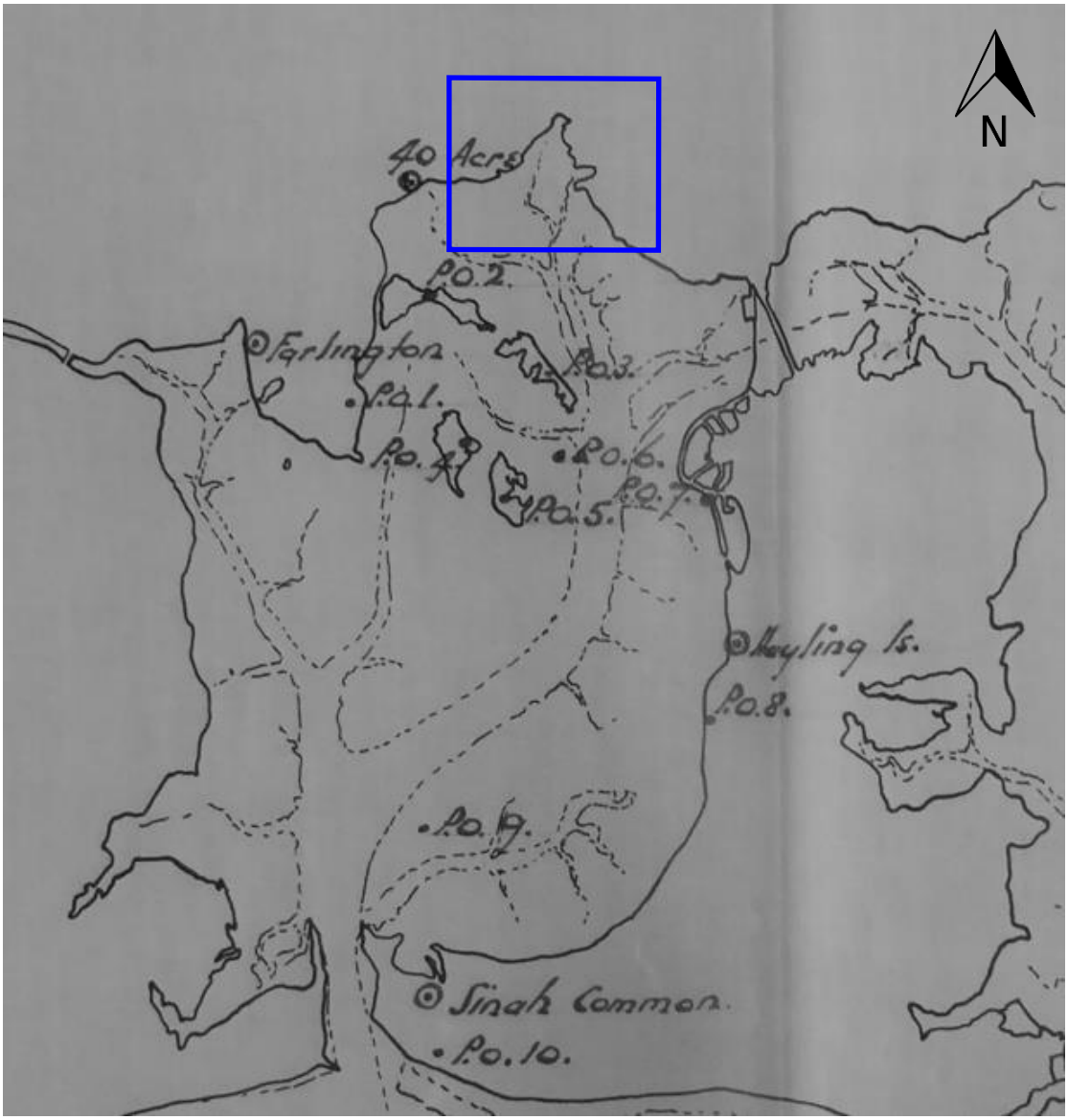
No military defences have been identified on the Site. The nearest are described below.

3.1.1 Bombing Decoys

During WWII 11No. bombing decoys were established in and around Langstone Harbour, in the vicinity of the Site, to replicate Portsmouth docks and harbour facilities. The nearest of these was located on North Binness Island (SU 695046), within approximately 0.4km southwest of the Site, and was designated PO2.

Figure 2 is a plan of Langstone Harbour dating from WWII. It shows the locations of the 11No. decoys.

Figure 2 Plan of bombing decoys around Langstone Harbour, WWII



Source: National Archives *Not to Scale*

Legend	Site boundary

Several associated observation posts were also established. 1No. of these was located at Forty Acre Farm (SU 692056), approximately 0.5km west of the Site.

The decoys in Langstone Harbour were effective in diverting German aircraft away from Portsmouth on several occasion (see Section 4.2).

Records indicate that there were 6No. air raids on the Langstone Harbour bombing decoys. Decoy PO10, within approximately 5.9km south of the Site, was the most successful SF decoy of WWII.

Potential UXO Hazard

Records indicate that the bombing decoys in the vicinity of the Site were very successful in diverting bombs away from Portsmouth during WWII.

Given the nature of Site and surrounding area, comprising mudflats, marshland and open water, bombs were often missed and not accurately recorded.

Bombing decoys are considered to provide a possible source of UXO hazard to the Site.

Further details on [redacted] on the Site are given in Section 4.2.

3.1.2 Anti-Aircraft Guns

During WWI there were 12No. Anti-Aircraft (AA) batteries within 10km of the Site. The nearest was located at Fort Purbrook (SU 678064), approximately 2km northwest of the Site. It was armed with 1No. 18-pounder(-pdr) gun.

During WWII there were 16No. Heavy AA (HAA) and ZAA batteries within 10km of the Site. The nearest was located at Moorlands (SU 686070), approximately 1.6km northwest of the Site. It was armed with 4No. 3.7-inch (") guns.

Potential UXO Hazard

Given the number of HAA gun batteries in the surrounding area during WWII, the potential for an Unexploded AA (UXAA) shell to have fallen on the Site unnoticed cannot be totally discounted.

3.2 Military Airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was No. 15 Kite Balloon Base (KBB) at Tipner (SU 636033), approximately 6.4km west-southwest of the Site. It operated between 1917 and August 1919.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Thorney Island (SU 762023), approximately 5.5km southeast of the Site.

Established in 1938 as a fighter base, RAF Thorney Island played an important role in the Battle of Britain in 1940.

By 1943 the airfield had been transferred to RAF Coastal Command and occupied by several squadrons from the RAF, Royal Canadian Air Force (RCAF) and Fleet Air Arm (FAA). Squadrons flew anti-shipping patrols and torpedo-bombing sorties across the English south coast and the English Channel.

Post-WWII RAF Thorney Island remained operational and in 1948 and 1949 it was used as a Royal Observers Corps (ROC) training camp. In 1976 the RAF left the airfield and by 1984 control was handed over to the Royal Artillery (RA). The former airfield was renamed Baker Barracks and continues to operate.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.3 Aircraft Crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- Aircraft Crashes

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.4 Explosives Factories, Munitions Depots and Disposal Areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.5 Firing Ranges and Military Training Areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

3.6 Other Military Establishments

No other military establishments have been identified on or in close proximity to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1. Alternatively, use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2. Alternatively, use the following link.

- [redacted]

Records indicate that parts of the Site were bombed during WWII. Further details on bombing in the vicinity of the Site are given in the following sections.

4.2.1 Bombing in Portsmouth & Langstone Harbour

From 1939 the south coast of England was subject to reconnaissance flights by the Luftwaffe. Strategic targets such as the Portsmouth Royal Dockyard, approximately 7.2km southwest of the Site, were photographed and mapped in detail. From the onset of WWII, mine-laying by the Luftwaffe along coasts and in estuaries such as the Solent and off Spithead became increasingly frequent.

Military establishments in the region such as airfields, naval bases and radar stations were specifically targeted. Records for heavy raids on many of the region's airfields and naval bases were suppressed until after WWII.

The distinctive coastline of the region was a major navigational aid for German bombers on their route to the strategic target areas around Portsmouth and further inland. The area around the Site was also subjected to 'tip and run' bombing raids.

In anticipation of heavy bombing over Portsmouth, from 1939 bombing decoys were established in and around Langstone Harbour to divert German aircraft over the relatively unpopulated island of Hayling and local mudflats. On the 17th April 1941, a decoy on Sinah Commons, approximately 5.9km south of the Site, attracted such an intense level of bombing that it became known as the most successful decoy of the war.

Portsmouth was heavily bombed during WWII and there were 69No. recorded air raids on Portsmouth. In total, approximately 1,262No. High Explosive (HE) bombs were reported falling within the city boundaries.

4.2.2 Strategic Targets

The Site was located in an area which contained numerous potential strategic targets, including military barracks, aircraft manufacturing works and testing airfields, and major transport infrastructure and public utilities.

Plate 4 is a Luftwaffe target photograph, dated the 3rd September 1941, of Portsmouth.

Several targets are identified, as summarised in Table 1.

Table 1 Luftwaffe targets in the vicinity of the Site

Target No.	Target
10 178	Airfield
52 32	Gasworks
74 48	Aircraft works
138	Barracks
41 31	Railway Bridge
178	Radio direction finder
23 32	Weapons store
43 31	Road bridge

Plate 2 Luftwaffe target photograph of Portsmouth, 3rd September 1941



Source: NARA *Not to Scale*

4.2.3 Bombing Densities and Incidents

Table 2 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal or Metropolitan Boroughs (MB) and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Table 2 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Havant & Waterloo UD	**375**	**39**	**9**	**423**	**35.0**
Portsmouth CB	1,221	34	7	1,262	136.8
Gosport MB	587	4	10	601	97.3
Fareham UD	447	11	18	476	25.9
Chichester RD	1,154	38	29	1,221	11.9
Petersfield RD	457	9	19	485	8.6

Note that Table 2 excludes the figures for Incendiary Bombs (IBs). Discrepancies between this list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further details of recorded bombing incidents in the immediate vicinity of the Site.

30th October 1940

1No. HE bomb fell on Southmere, Havant, approximately 0.3km east of the Site.

5th December 1940

Several HEs bombs fell in Langstone Harbour, in the vicinity of the Site.

15th January 1941

1No. Delayed Action Bomb (DAB) fell in Langstone Harbour, south of Bedhampton Mill, on the Site.

11th April 1941

8No. HE bombs fell in Langstone Harbour, between Farlington and Langstone Bridge, within approximately 0.3km south of the Site.

5th June 1941

1No. HE bomb fell in the north end of Langstone Harbour, on the Site.

9th June 1941

2No. HE bombs fell in Langstone Harbour, near Binness Island, within approximately 0.3km south of the Site.

Plates 3 and 4 are aerial photographs of the Site, dated the 9th April 1942. No bomb damage or cratering has been identified on the Site.

It should also be noted that in marshland and saturated clay, bomb impact features are often difficult to distinguish due to deeper penetration and camouflets.

Plate 3 Aerial photograph of the western part of the Site, 9th April 1942



Source: NCAP *Not to Scale*

Legend	Site boundary

Plate 4 Aerial photograph of the eastern part of the Site, 9th April 1942



Source: NCAP *Not to Scale*

Legend	Site boundary

21st August 1942

4No. HE bombs fell on Ranelagh Road, approximately 0.3km north of the Site.

6th August 1943

Several IBs fell in a field behind the waterworks on Brockhampton Road, approximately 0.1km northeast of the Site.

15th August 1943

2No. HE bombs fell in the sea off Farlington Marshes, approximately 0.3km west of the Site.

3No. HE bombs fell on the foreshore near Forty Acre Farm, approximately 0.3km west of the Site.

Approximately 40No. HE bombs fell in Langstone Harbour, in the vicinity of the Site.

16th August 1943

Several IBs fell across Broad Marsh, on the Site.

1No. Oil Bomb (OB) and several IBs fell in a field behind waterworks on Brockhampton Road, approximately 0.1km northeast of the Site.

26th April 1944

At least 8No. HE bombs fell in Langstone Harbour, near Baker Island, in the vicinity of the Site.

15th May 1944

At least 22No. HE bombs fell in Langstone Harbour, in the vicinity of the Site.

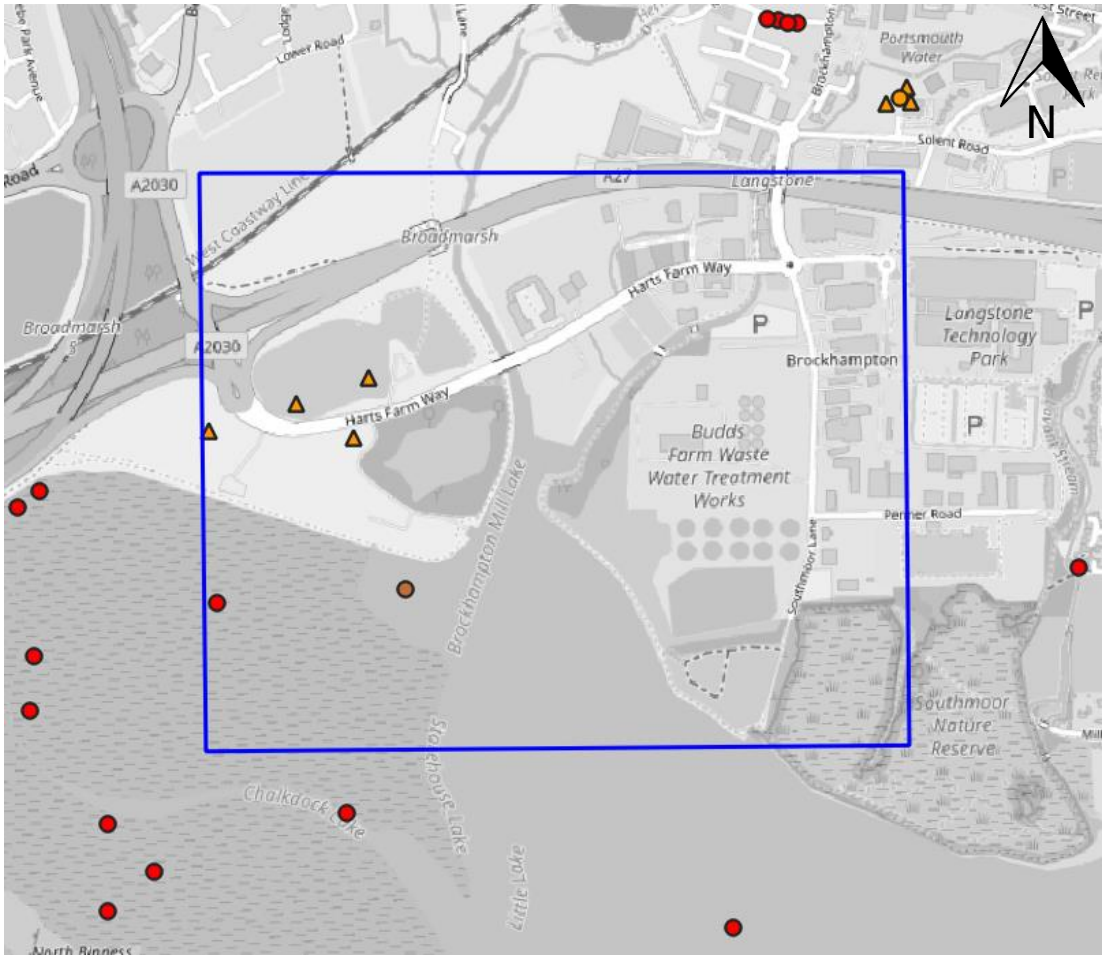
It should be noted that during WWII, many Unexploded Bombs (UXB) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXB were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from a number of different sources, including air raid incident reports, historical aerial photographs and bomb census maps.

The bomb map is also given in the accompanying P11650-22-R1-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	OB	IBs	DAB

Plates 5 and 6 are aerial photographs of the Site, dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

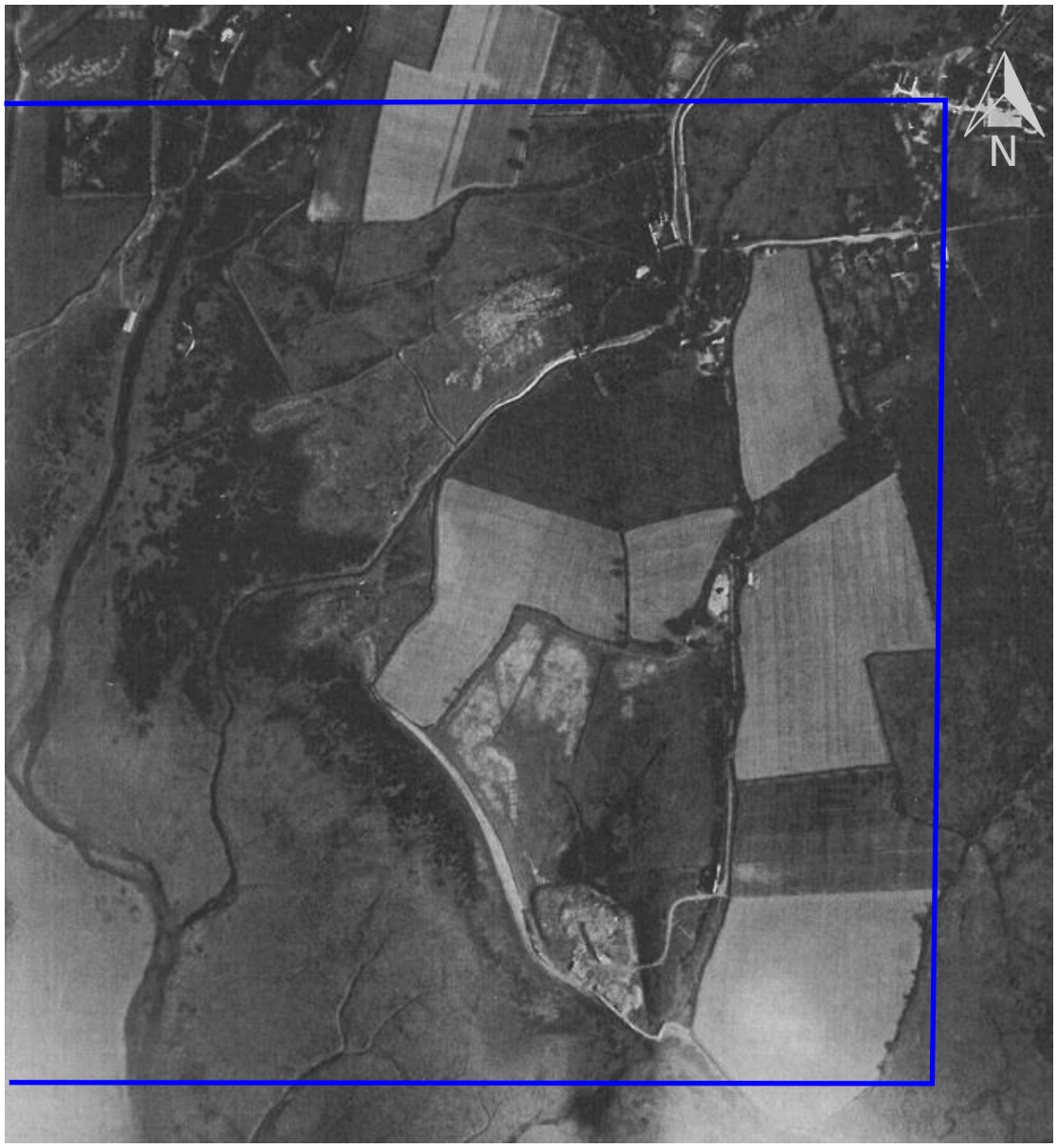
Plate 5 Aerial photograph of the western part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 6 Aerial photograph of the eastern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO Hazard

Records have been found indicating that at least 300No. HE bombs fell in Langstone Harbour, in the vicinity of the Site, during heavy air raids in WWII.

It is considered possible that UXBs falling on parts of the Site comprising and mudflats and water may have been missed and not retrieved. Given this, it is considered possible that a UXB could have fallen on the southern and central parts of the Site and gone unnoticed.

No evidence of significant bombing has been identified on the remainder of the Site, which mainly comprised agricultural fields.

[redacted] is considered to provide a possible source of UXO hazard to the southern and central parts of the Site.

4.2.4 Geology and Bomb Penetration Depths

It is important to consider the geological materials present at the time that a bomb was dropped in order to establish its maximum penetration depth.

At the time of writing, no Site-specific ground investigation data was available.

British Geological Survey BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from on and near the Site were consulted to get an indicative overview of the Site geology.

The geology of the parts of the Site comprising open fields is understood to consist of topsoil, over clay, silt, sand, and gravel of alluvial and river terrace deposits, overlying chalk of the Lewes Nodular, Seaford, Newhaven, Culver, and Portsdown Chalk Formations.

Table 3 provides an estimate of average maximum bomb penetration depths during WWII assuming WWII ground conditions of 0.5m of topsoil (modelled as wet clay), over 2.5m of firm clay, over 5m of gravel, overlying more than 20m of chalk.

Table 3 Estimated average maximum bomb penetration depths (open fields)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	4.0m
	500kg	7.5m
	1,000kg	10.0m

The geology of the parts of the Site comprising marshland is understood to consist of silt, sand, and gravel Alluvium, river terrace and raised marine deposits, overlying chalk of the Lewes Nodular, Seaford, Newhaven, Culver, and Portsdown Chalk Formations.

Table 4 provides an estimate of average maximum bomb penetration depths during WWII assuming WWII ground conditions of 0.5m of topsoil (modelled as wet clay), over 2m of soft clay, over 2m of gravel, overlying more than 20m of weak rock.

Table 4 Estimated average maximum bomb penetration depths (marshland)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	4.0m
	500kg	11.5m
	1,000kg	14.0m

The geology of the part of the Site in Langstone Harbour is understood to consist of open water, over clay, silt, sand, and gravel beach and tidal flat deposits, overlying chalk of the Lewes Nodular, Seaford, Newhaven, Culver, and Portsdown Chalk Formations.

Table 5 provides an estimate of average maximum bomb penetration depths during WWII assuming WWII ground conditions of 0.5m of silt, over 1m of wet clay, over 3m of gravel, overlying more than 20m of chalk.

Table 5 Estimated average maximum bomb penetration depths (Langstone Harbour)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.5m
	500kg	10.0m
	1,000kg	12.5m

Vertical or near vertical deployment of ordnance to the seabed in deeper water is extremely unlikely due to deflection by waves at the sea surface and the initial aerial trajectory of air-

delivered ordnance. This is the case even from high level delivery but especially from low level, dive bombing or extra low (sub-radar) mine laying and torpedo attacks.

As ordnance passes through a water column, it loses its air-water interface impact velocity, and hence momentum, due to hydrodynamic drag during its submarine trajectory. Initial impact energy is dissipated exponentially as the ordnance travels through the denser water media. At a critical depth, the ordnance loses enough forward momentum to assume a low angle 'glide' path downwards.

It then sinks to the seabed, attaining only the maximum free fall velocity and momentum possible after overcoming the hydrodynamic drag forces in the remaining depth of the water column. It impacts with minimal impact velocity and momentum onto the seabed.

For offshore sites located in deeper water which has a sand and gravel substrate maintained by strong tidal currents, penetration depths are likely to be less than the theoretical ones given in Table 5.

Most UXB are likely to remain on or near the seabed and be prone to tidal marine processes, as outlined in Section 5.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Tables 3 – 5 are from the WWII ground level and are based on the following assumptions:

a) High level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 degrees to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

A high altitude release of a bomb will result in ground entry at between 10° and 15° to the vertical with the bomb travelling on this trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked lateral movement from the original line of entry is common.

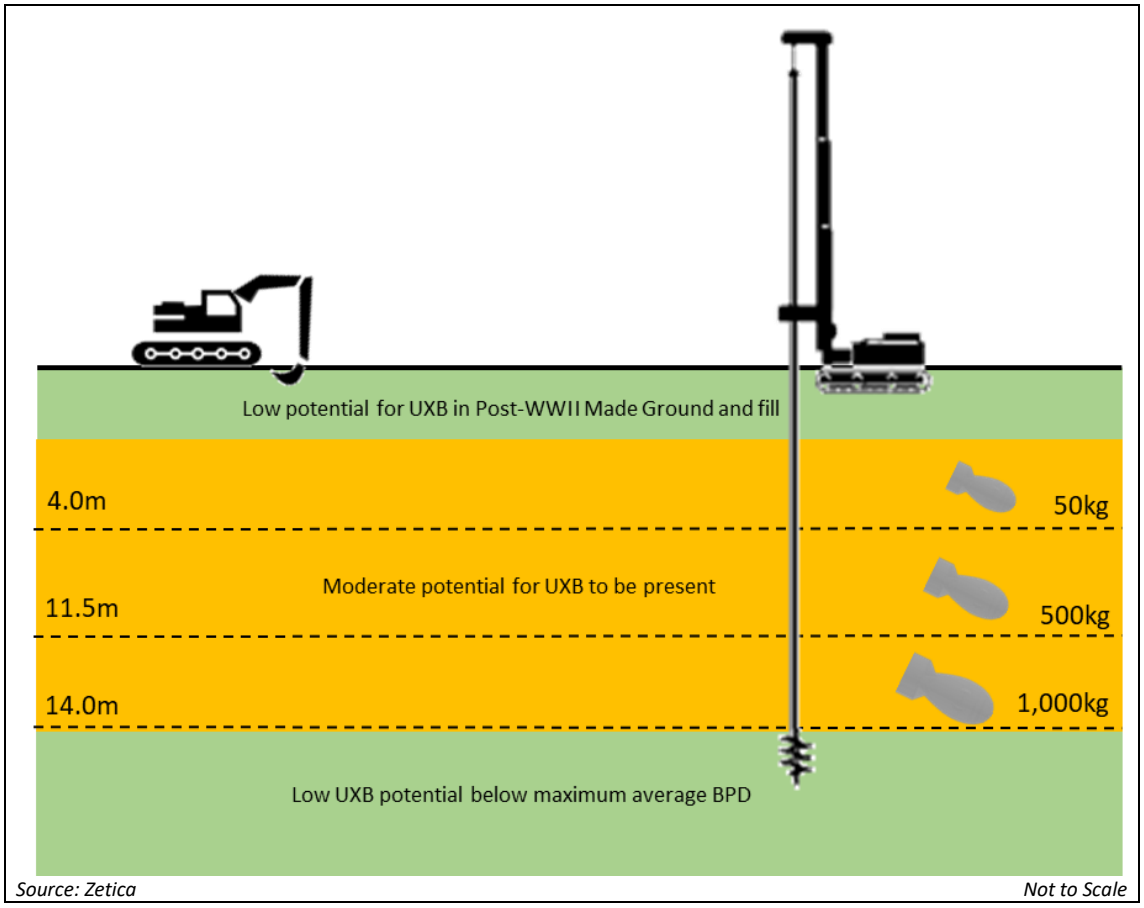
Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth, i.e. an offset of 2m may be expected for a 50kg bomb in dry silts and clays. If hard standings or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

Figure 4 demonstrates the potential burial setting for a UXB on the Site, based on the anticipated ground conditions and average maximum bomb penetration depth.

Note that the depths given are from the WWII ground level.

Figure 4 Potential burial setting of UXB on the Site



Source: Zetica *Not to Scale*

5 UXO IN THE MARINE ENVIRONMENT

Both wartime and peace time military and naval activities provide numerous sources of UXO within the marine environment. The principal sources of UXO hazards are from ordnance disposal at sea, WWII aerial laid mines, mines laid as beach defences, crashed aircraft and wrecks containing ordnance.

Clearance certification for UXO within a marine environment may be valid only for a limited period as storms, tides and general current movement can cause UXO to migrate into an area that may have been cleared of UXO only hours before. This also makes it very difficult to accurately predict where UXO may be found.

UXO is most likely to be concentrated on and immediately around the principal sources of the UXO hazard. These are typically ordnance disposal sites at sea, WWII mines, marine ranges and wrecks containing ordnance.

5.1 Marine Ranges and Training Areas

The nearest offshore ranges and training areas which may have contributed UXO to the marine environment in the vicinity of the Site are described below.

5.1.1 Portsmouth Artillery and Bombing Ranges

During WWI and prior to WWII there were several offshore artillery, bombing, and gunnery ranges in the vicinity of the Site.

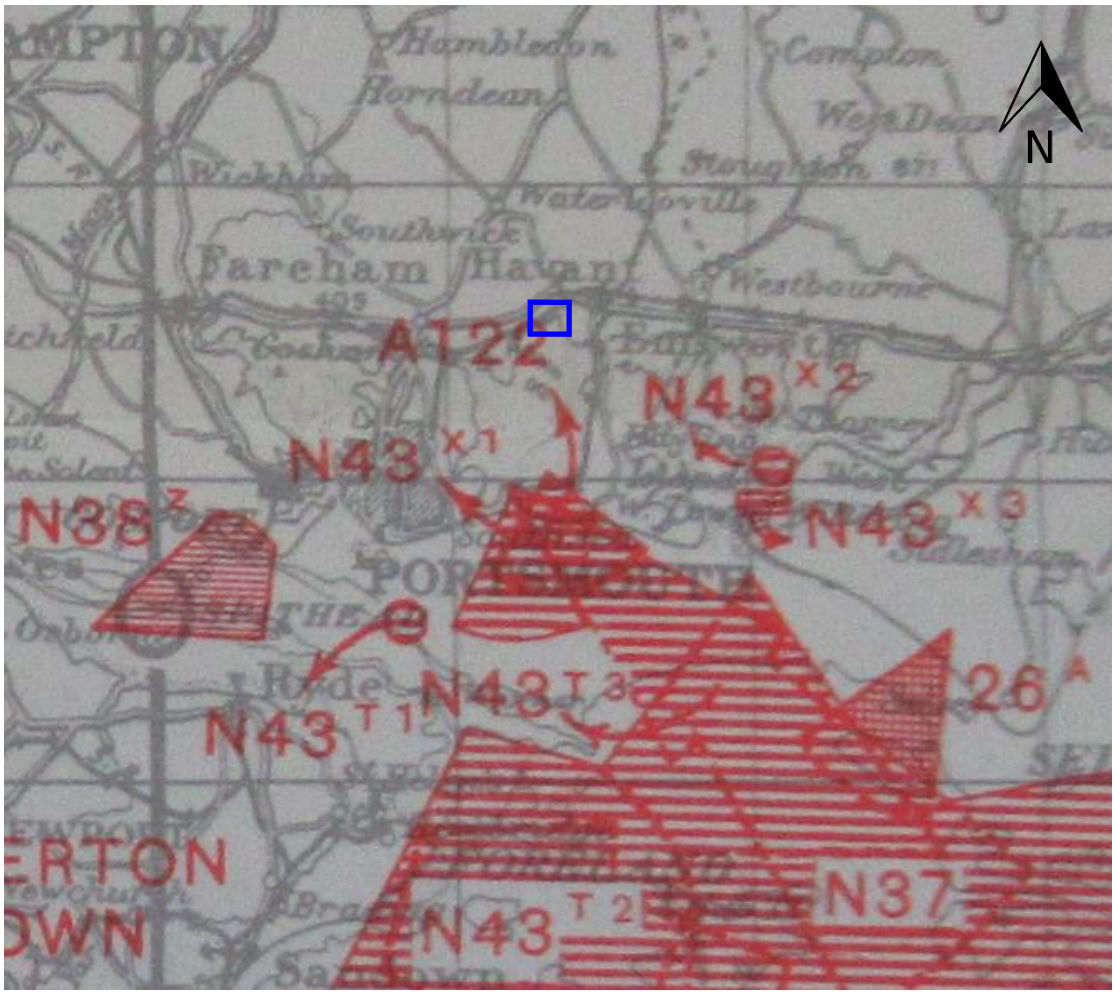
During WWII, several new offshore ranges were established in the vicinity of the Site.

The nearest of these included Eastney Range (N37) for Light AA (LAA) and HAA practice, the Sinah Range (A122) for HAA practice, and the Solent Spithead Ranges (N38N and N38Z) for running torpedoes dropped from aircraft. These ranges were all located more than 4.5km south of the Site.

Additionally, the Portsmouth East Ranges (N43T1, N43T2 and N43T3) were used for naval gun trials, Portsmouth East Range (N43T4) for gun and HAA practice, the Portsmouth East Ranges (N43X1, N43X2 and N43X3) were used for explosives trials, including experimental mines and depth charges, and the Selsey Range (26A) was used for Air-to-Air (AtA) gunnery and as a bombing range. These ranges were all located over 10km from the Site.

Figure 5 is an extract of a plan showing the location of offshore ranges, dating from 1945.

Figure 5 Extract of plan showing offshore ranges in the vicinity of the Site, 1945



Source: National Archives *Not to Scale*

Legend		
	Site boundary	LAA, HAA, naval gun, and explosives ranges
	Torpedo range	AtA gunnery and bombing range

Potential UXO Hazard

Offshore ranges are not considered to provide a source of UXO hazard on the Site.

The ranges will have contributed UXO to the marine environment in the vicinity of the Site (see Section 5.5).

5.2 Marine Mines

For further information on marine mines, and the potential UXO hazards associated with them, see Appendix 2.5.

5.2.1 WWI Minefields

German mines were deployed from submarines and surface ships in the approaches to the Solent, within approximately 12.3km south-southeast of the Site.

5.2.2 WWII Minefields

Defensive minefields are recorded along the Hampshire coastline within the wider vicinity of the Site. These beach minefields were systematically cleared during and after WWII using available plans and techniques.

German mine laying from Luftwaffe aircraft, submarines, E-Boats, and other surface vessels took place throughout WWII in the Portsmouth area, to within approximately 4km south of the Site.

Records indicate that marine mines were dropped by the Luftwaffe in Langstone Harbour, within approximately 2km of the Site.

There are records of vessels striking mines and sinking in the vicinity of the Site, as illustrated in Section 5.3.

Potential UXO Hazard

Mines are not considered to provide a significant source of UXO hazard to the Site.

The possibility that marine, beach or other defensive mines, displaced by coastal erosion and marine processes, may have contributed UXO to the marine environment in the vicinity of the Site cannot be discounted.

5.3 Wrecks Containing UXO

No records have been found indicating that any wrecks which may contain UXO are located on or in close proximity to the Site.

The nearest wreck sunk during WWII is detailed below.

Wreck No. 19213

The tug *SS Irishman* struck an aerial mine (likely a Parachute Mine (PM)) laid from a German aircraft) and sank approximately 4km south of the Site on the 8th May 1941.

Potential UXO Hazard

Wrecks are not considered to provide a source of UXO hazard to the Site, although they may contribute to the general background risk of UXO in the marine environment.

5.4 Munitions Disposal at Sea

No records have been found indicating that offshore munitions disposal has occurred on or in the vicinity of the Site.

Recent Admiralty charts show an offshore ordnance disposal area (X5037), over 12km south-southwest of the Site.

This is not considered to provide a source of UXO hazard to the Site.

5.5 Potential for Marine UXO Migration

There are several potential sources of UXO hazard in the marine environment in the vicinity of the Site, including marine ranges, mines, air-dropped bombs (see Sections 3 and 4), and AA shells.

The tidal currents, wave actions and sediment movements are discussed in detail in Appendix 6.

Given the tidal currents, wave action and pattern of sediment movement in the vicinity of the Site, it is considered that the largest UXO, too heavy for the waves and near shore currents to move, are unlikely to be transported far but rather would be exposed by scour around them or, potentially, fishing and dredging activities, and then be left proud of the sediments.

In such cases, the UXO are unlikely to move from source unless fishing or dredging activities disturb the exposed UXO.

Buoyant and semi-buoyant UXO (as may be the case with some marine mines or degrading ordnance), smaller, lighter items of UXO (such as SAA and small or medium calibre shells) and UXO with neutral buoyancy could move by saltation or roll as bed load particles during ebb or flood tides, especially along the deeper channels or downslope into the channels from the edges of the channel.

The possibility that such UXO may migrate onto the Site in the subtidal and intertidal zones, up to the high-water mark, although unlikely, cannot be entirely discounted, as shown by recent finds (see Section 6.2).

Given the extent of military and naval activity on and in close proximity to the Site, and the possibility of UXO migration due to fishing or dredging activities and marine processes such as tidal currents and storm waves, it is considered that there is a potential for UXO in the form of AA and artillery shells and small to intermediate sized UXB, to migrate onto the Site.

This potential marine migration of ordnance onto the Site forms part of the background risk of encountering UXO on any similar site in the UK.

6 EXPLOSIVE ORDNANCE CLEARANCE ACTIVITIES

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (representing 11%) were recorded as UXBs. However, records from the Royal Engineers who were responsible for bomb disposal at the time indicate that as of 27th February 1946 upwards of 45,000No. UXBs were disposed of.

On average 8.5% of UXBs later self-exploded. In some cases the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office statistics also show that between October 1940 and May 1941 most of the UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and the size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

6.1 Abandoned Bombs

For further information on abandoned bombs, and the potential UXO hazard associated with them, follow the link below:

- Abandoned Bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

6.2 EOC Tasks

Records held by Zetica Ltd show that the following post-WWII EOC tasks have taken place in the vicinity of the Site.

25th April 2010

1No. 50kg German UXB was found by fishermen in Langstone Harbour, within approximately 1.5km of the Site and dragged onto the beach near Hayling Ferry, over 4km south of the Site. This was disposed of on the same day.

30th September 2016

Several time expired pyrotechnics (TEP) were found and removed from Farlington Marshes, within approximately 1km southwest of the Site.

17th April 2019

1No. unexploded shell was discovered at the Havant Waste Recycling Centre, on the Site. It was removed and disposed of by the Royal Navy (RN).

19th December 2019

Suspected chemical-filled mortar rounds were recovered from Farlington Marshes, within approximately 1km southwest of the Site. They were removed and taken to Porton Down for disposal.

7 UXO HAZARD ASSESSMENT

7.1 UXO Hazard Level

The definitions for the levels of UXO hazard are provided below.

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

Records have been found indicating that at least 300No. HE bombs fell in Langstone Harbour, in the vicinity of the Site, during heavy air raids in WWII.

It is considered possible that UXBs falling on parts of the Site comprising and mudflats and water may have been missed and not retrieved. These parts of the Site are assigned a moderate UXO hazard level.

No evidence of significant bombing or other military activity has been identified on the remainder of the Site, which mainly comprised agricultural fields. These areas are assigned a low UXO hazard level.

It is considered that the UXO hazard level on the Site can be zoned from low to moderate, as shown in Figure 6.

The UXO hazard zone plan of the Site is also given in the accompanying P11650-22-R1-MAP01-A.

It should be noted that significant land reclamation has occurred on parts of the Site assigned a moderate UXO hazard level. The UXO hazard level can be reduced to low within the depth and extents of the post-WWII fill material, which is assumed not to contain UXO.

Figure 6 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

Note that the UXO hazard will have been mitigated within the depth and extents of any post-WWII intrusive works or post-WWII fill.

8 UXO RISK ASSESSMENT

8.1 Proposed Works

It is understood that initial works on the Site will comprise ground investigations, including trial pits and boreholes.

Future works on the Site may be associated with WTW renewal services and may include further intrusive ground investigations, excavations, and piling.

It is understood that at present no intrusive works are expected to be undertaken in the waters of Langstone Harbour on the southern part of the Site.

8.2 Risk Assessment Methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard.

Firstly, the probability of encountering UXO (PE) has been considered and rated for the different construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating a UXO (PD) has been considered and rated for the different construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works is multiplied by the severity of such an event occurring (P x S), in order to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

8.3 UXO Risk Level

The UXO risk assessment for proposed works on the Site is given in Table 6.

Table 6 UXO risk assessment for the Site

Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Moderate	UXB	Excavations in post-WWII fill	1	1	1	1	5	5	Low
		Excavations below post-WWII fill	3	2	6	3	5	15	Moderate
		Boreholes/Piling	2	3	6	3	4	12	Moderate
	Other UXO	Excavations in post-WWII fill	1	1	1	1	4	4	Low
		Excavations below post-WWII fill	1	1	1	1	4	4	Low
		Boreholes/Piling	1	1	1	1	3	3	Low
Low	UXB	Excavations in post-WWII fill	1	1	1	1	5	5	Low
		Excavations below post-WWII fill	1	1	1	1	5	5	Low
		Boreholes/Piling	1	1	1	1	4	4	Low
	Other UXO	Excavations in post-WWII fill	1	1	1	1	4	4	Low
		Excavations below post-WWII fill	1	1	1	1	4	4	Low
		Boreholes/Piling	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)									

9 RISK MITIGATION PLAN

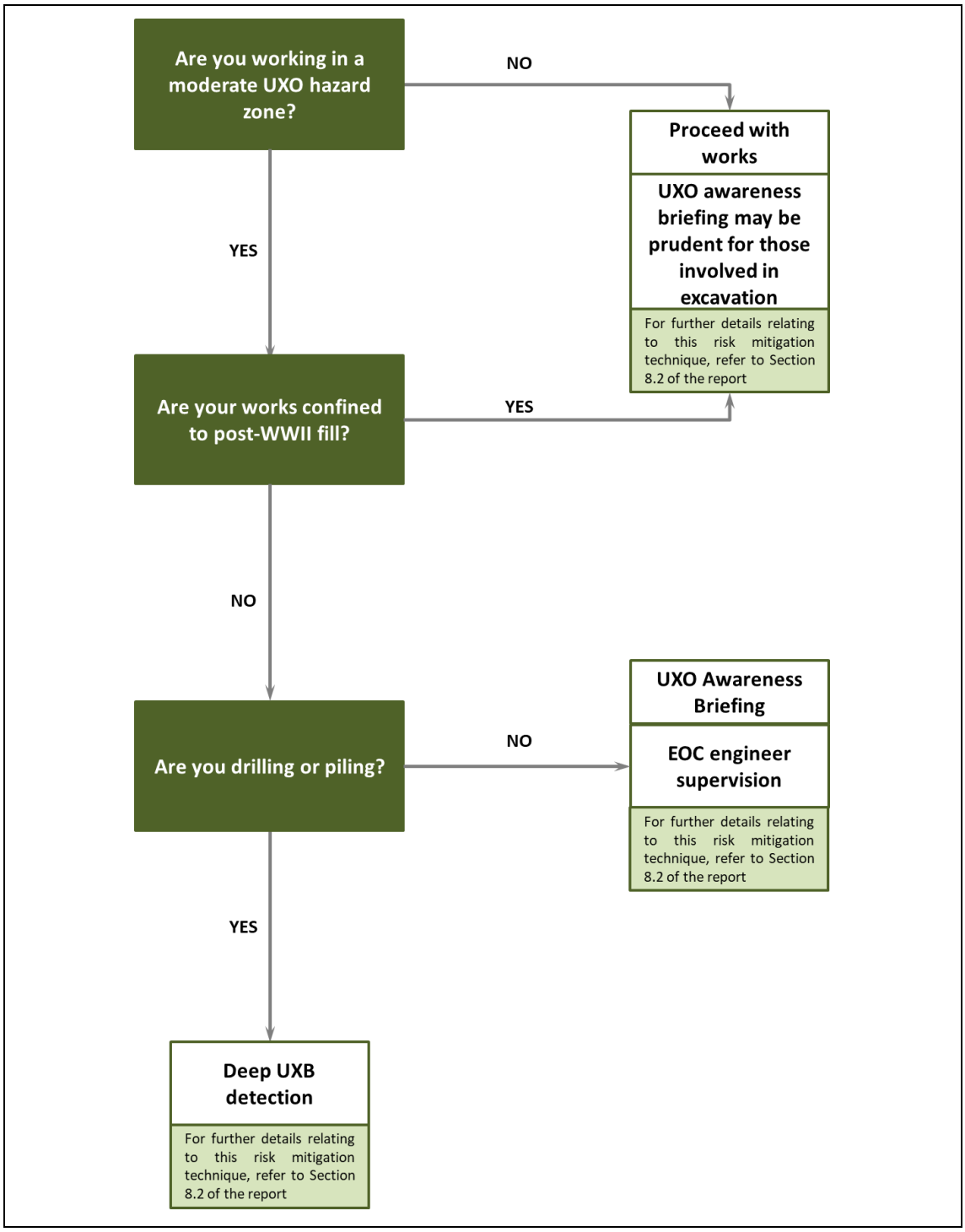
Key findings: Potential hazard from UXB on parts of the Site occupied by mudflats and water during WWII.

Key actions: EOC engineer supervision for excavations disturbing the WWII land surface in the moderate UXO hazard zone.

To clear borehole or pile locations in these areas, deep UXB detection is required.

Figure 7 outlines the recommended steps to reduce the UXO risk to ALARP.

Figure 7 Recommended risk mitigation plan for the Site



9.1 UXO Risk Summary

Table 7 summarises the most appropriate risk mitigation recommendations for the proposed works on the Site.

Table 7 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – if additional comfort is required to address the residual UXO hazard, a formal UXO awareness briefing can be provided.
Boreholes/Piling		**Proceed with works**
Excavations		**EOC Engineer Supervision** – to ensure safety and minimise delays, Explosive Ordnance Clearance (EOC) Engineer supervision is recommended.
Boreholes/Piling		**Deep UXB detection –** to clear borehole and pile locations of potential UXB, an intrusive magnetometer survey should be undertaken until either the maximum bomb penetration or maximum drilling/piling depth is reached.

In summary, if works in the moderate UXO hazard zone cannot be confined to post-WWII fill material, an EOC Engineer should supervise excavation works and deep UXB detection should be undertaken at borehole and pile locations.

9.2 Risk Mitigation Techniques

The section below provides further details of the recommended techniques for mitigating the UXO risk on the Site.

9.2.1 UXO Awareness Briefing

Typically ~1hour in duration, these briefings will be expected to provide site workers with:-

- Background to the potential UXO hazards that could be encountered.
- Awareness of how the UXO hazard could present a risk.
- Knowledge of what to do in the event that a suspect item is encountered.

The briefing is to be provided along with back-up materials such as UXO awareness posters, emergency contact numbers and other background information to assist site workers in becoming familiar with what potential UXO can look like.

The materials can also be used by key staff to pass on the relevant points of the induction to others who visit or work on the Site.

By providing the UXO awareness briefing, it ensures that in the unlikely event that UXO is encountered:-

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.

- Significant delays to site work are prevented.

9.2.2 EOC Engineer Supervision

An EOC engineer can attend site and supervise during excavation works if required.

The EOC engineer will carry out a visual assessment on any suspect items uncovered during the excavation works and classify them as potential UXO or other material.

If an item of UXO is uncovered, the EOC engineer will liaise with the authorities and arrange for its disposal as appropriate.

9.2.3 Deep UXB Detection

To clear borehole or pile positions of potential UXB, an intrusive magnetometer survey should be undertaken.

The survey should be carried out to either the maximum bomb penetration depth or maximum drilling/piling depth, whichever is shallower.

There are two main systems available:-

MagDrill (Boreholes) – this is a system that is suitable for working with ground investigation drillers.

It allows a magnetometer to be lowered into the borehole to ensure the route is clear of potential UXB.

MagCone (Piles) – this is a CPT-based system that facilitates the pushing of a magnetometer into the ground at the proposed location of a pile.

MagCone is suitable for cohesive/loose soils and has a much higher speed of operation compared to MagDrill. It should be noted that where dense soils or buried obstructions are encountered, MagCone is unlikely to be able to penetrate to the required depth.

Detection - Typical radius of detection should be assumed as approximately 1.0m for a 50kg UXB until site conditions are confirmed.

Assuming no objects comparable to the UXB detection range are identified, then the borehole or pile position can be considered clear of UXB.

If any ferrous anomalies are identified at the borehole or pile position, then it may need to be relocated or the anomaly investigated.

It should be noted that in Made Ground or close to buried/adjacent structures, effective UXB detection is compromised due to geophysical noise.

A clearance report should be issued on completion of the site works.

9.3 What Do I Do Next?

If you wish to proceed with UXO risk mitigation, Zetica would be happy to assist. Just contact us via phone (01993 886682) or email ([redacted] and we can provide a proposal with options and prices.

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

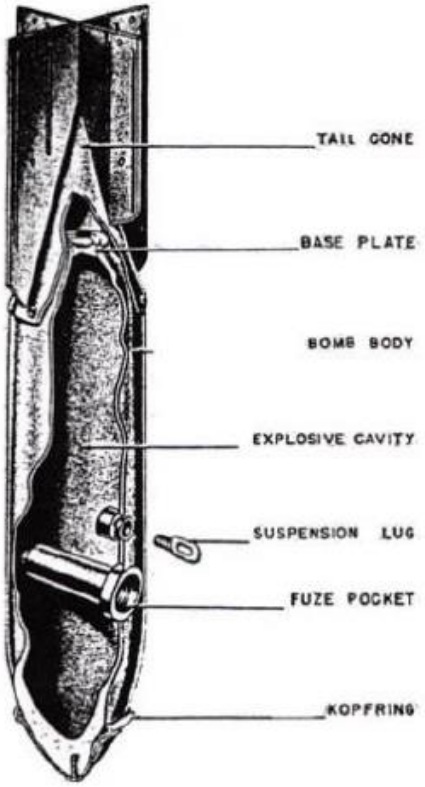
Appendix 1 Anticipated Ordnance Types

The most likely ordnance types to be encountered on the Site are detailed below. For a more comprehensive set of ordnance data sheets, see http://[redacted]downloads-and-resources/ordnance-data-sheets/.

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



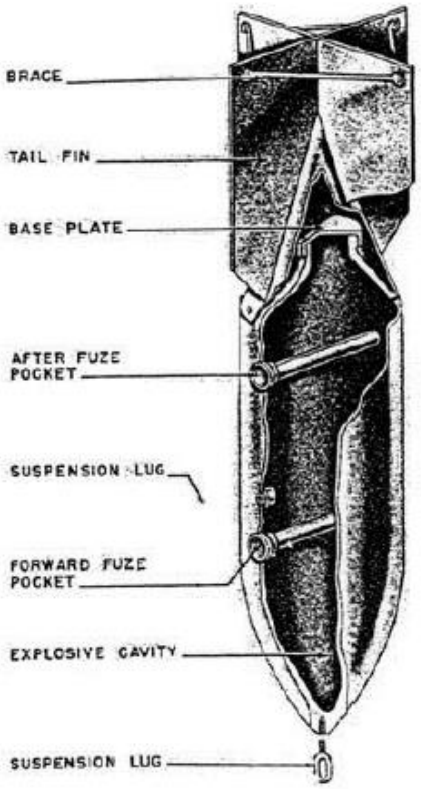




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



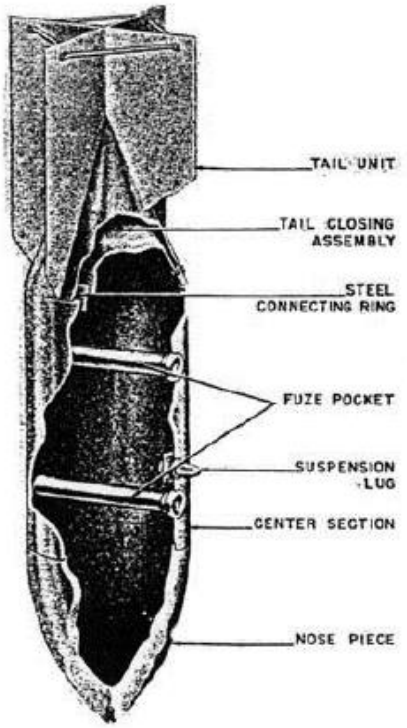




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



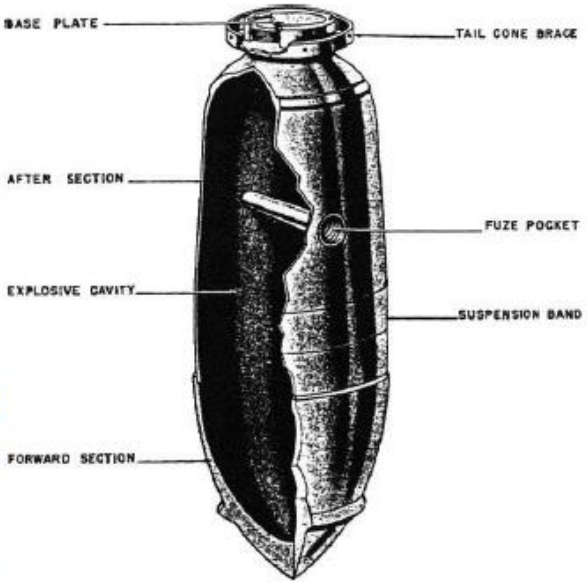


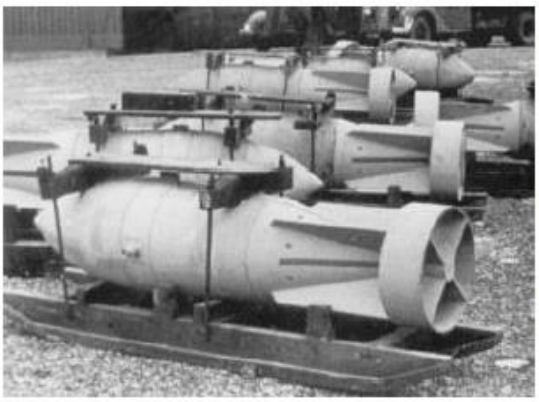


Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 1,000kg (HERMANN)

Variants	3
Body Dimensions	1742-1905mm x 648–660mm (68.6-75" x 25.5-26")
Weight	1,000-1,088kg (2,204-2,398lbs)
Charge Weight	529-619kg (1,166-1,364lbs)
Fuze	Electric impact fuze/ electric clockwork time fuze & electric anti-disturbance fuze
Composition	Magnesium alloy with drum
Description	Thick nose welded to steel body. Nose attached to Kopfring (triangular section steel ring). Drum-shaped tail made of magnesium alloy. Suspension band. Originally painted sky-blue. Filled with amatol, TNT/aluminium/wood meal or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition.



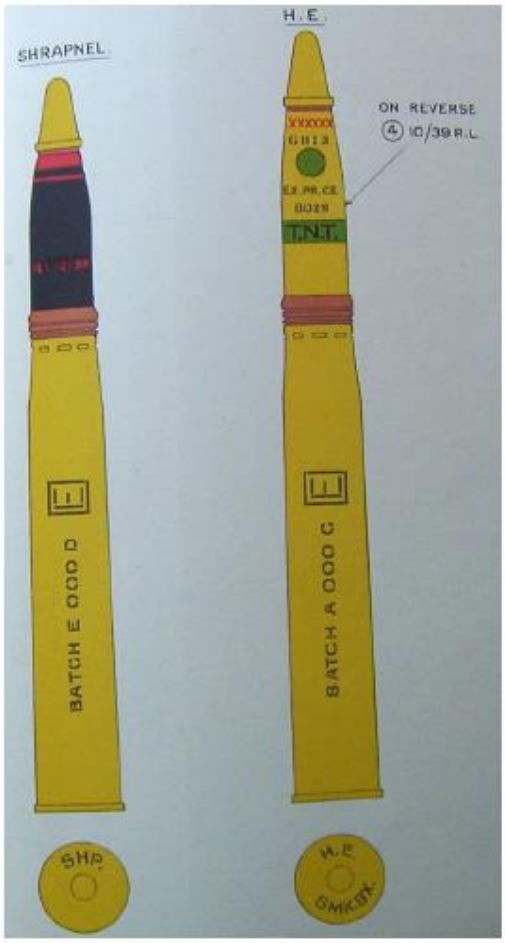




Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.



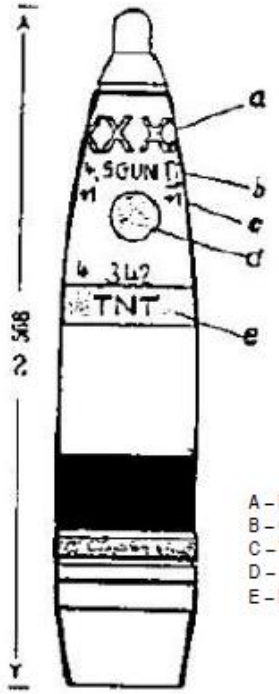




Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants	-
Body Dimensions	114mm x 566mm (4.5" x 21.9")
Weight	24.9kg (55lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.
Function	Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO Hazard

The sections below provide background information on the most likely sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see http://[redacted]downloads-and-resources/uxo-information-sheets/.

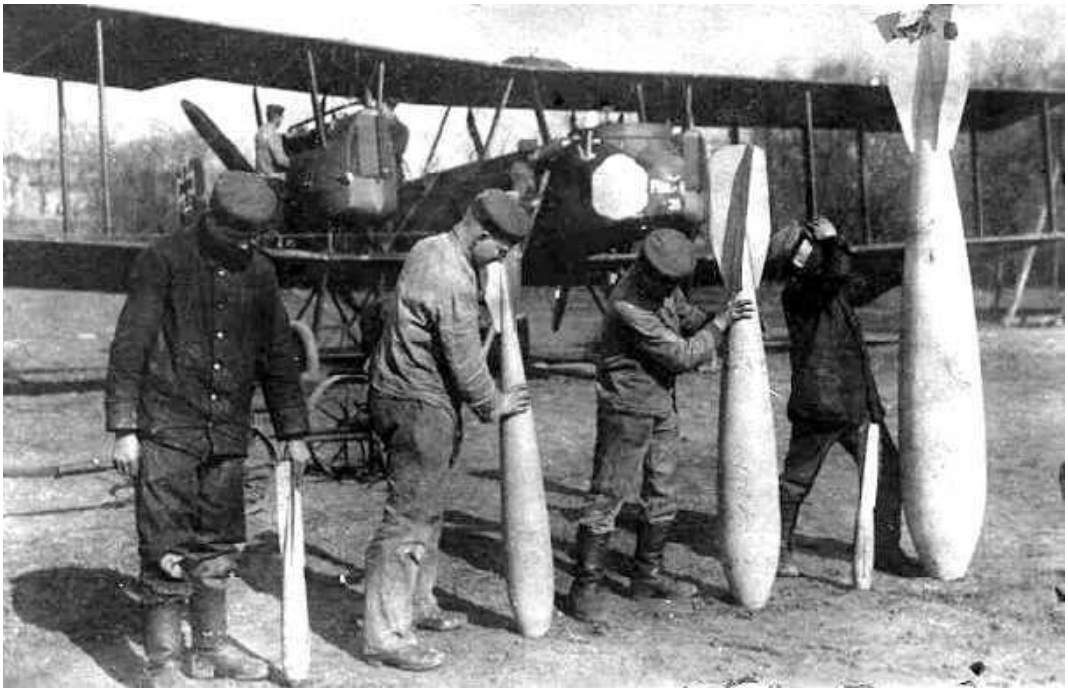
Appendix 2.1 [redacted]

It is not generally realised that during World War One (WWI) significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used. More than 1,400No. people were killed during these raids.

Most air raids were carried out on London and Southeast England. Areas along the East Coast were also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. high explosive bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than a WWII UXB given the lower bombing densities during raids in the Great War.

Some areas which were subjected to sustained bombing raids, such as parts of London and coastal towns, recorded a higher number of UXB. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Bombing raids began in the summer of 1940 and continued until the end of [redacted] densities generally increased towards major cities or strategic targets such as docks, harbours, industrial premises, power stations and airfields. In addition to London, industrial cities and ports, including Birmingham, Coventry, Southampton, Liverpool, Hull and Glasgow, were heavily targeted, as well as seaside towns such as Eastbourne and cathedral cities such as Canterbury.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). The most common HE bombs were the 50kg and 250kg bombs, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped.

The HE bombs tended to contain about half of their weight in explosives and were fitted with one or sometimes two fuzes. Not all HE bombs were intended to explode on impact. Some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied Incendiary Bombs (IBs) to a 250kg 'Oil Bomb' (OB) and a 500kg 'C300' IB. In some cases the IBs were fitted with a bursting charge. This exploded after the bomb had been alight for a few minutes causing burning debris to be scattered over a greater area. The C300 bombs were similar in appearance to 500kg HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineers to deal with their disposal.



Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. 2No. types of anti-personnel bombs were in common use, the 2kg and the 12kg bomb. The 2kg bomb could inflict injury across an area up to 150m away from the impact. PMs (which were up to 4m in length) could be detonated either magnetically or by noise/vibration.

Anti-shipping parachute mines were commonly dropped over navigable rivers, dockland areas and coastlines. The Royal Navy was responsible for ensuring that the bombs were made safe. Removal and disposal was still the responsibility of the Bomb Disposal Unit of the Royal Engineers.

In 1944, the Germans introduced new weapons; the V1, a 'flying bomb' and guided missile, and the V2, a ballistic missile rocket that travelled at such speed that no one could see or hear its approach. London was the main target for these attacks.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs which was aimed at a specific location might not just miss the intended target but fall some considerable distance away.



It is understood that the local Civil Defence authorities in urban areas had a comprehensive system for reporting bomb incidents and dealing with any Unexploded Bombs (UXB) or other UXO. In more rural areas, fewer bombing raids occurred. It is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling in rural and coastal areas. Bombs were either released over targets or as part of 'tip and run' raids where bomber crews would drop their bombs to avoid anti-aircraft fire or Allied fighter aircraft on the route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids on rural and coastal areas often went unrecorded or entered as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout the Second World War and an estimated 11% of all bombs dropped during the war failed to detonate.

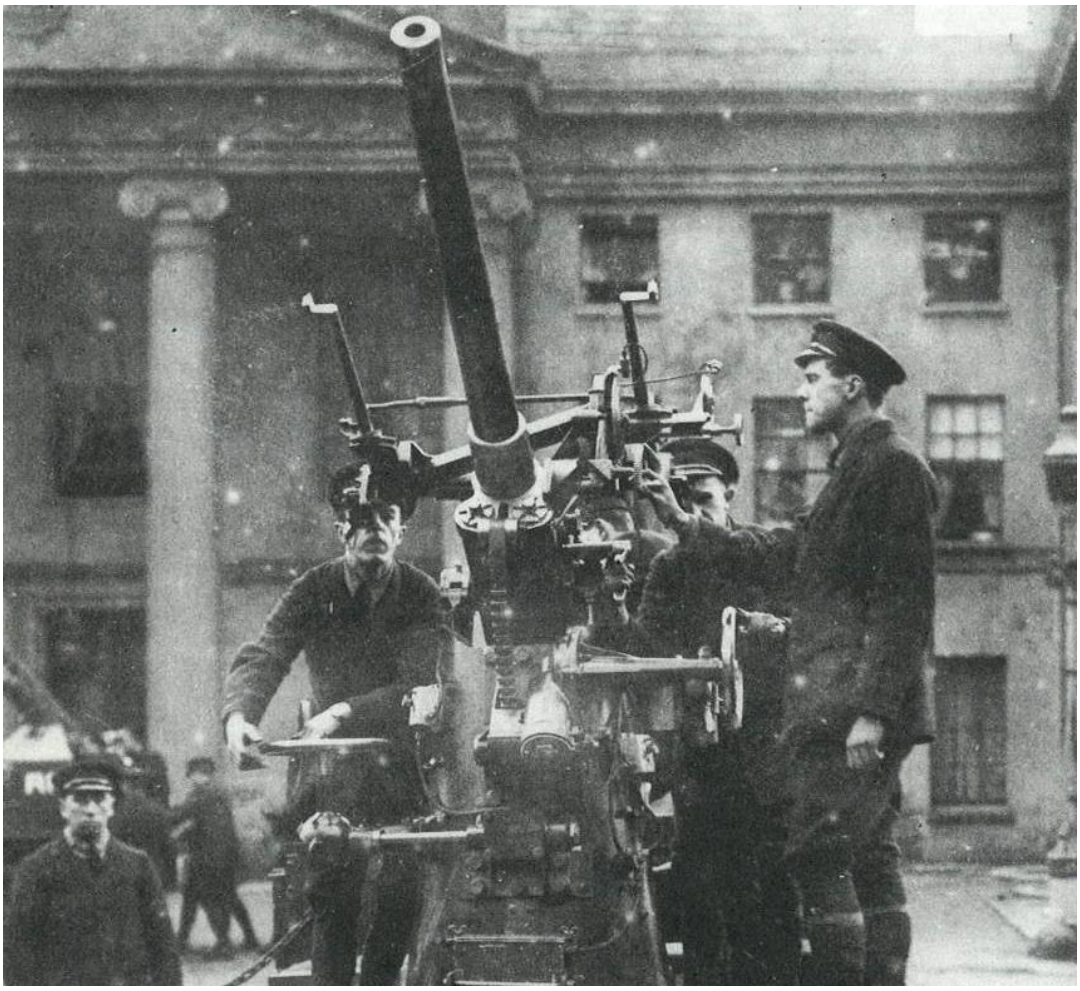
The potential for a UXB hazard to exist on a site depends on a variety of factors. Were there strategic targets in the surrounding area? Was the site bombed? Could a UXB impact have been missed? Even in rural areas, the potential for UXB cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft Guns

As aerial bombardment first began during WWI, Anti-Aircraft (AA) gun batteries were established were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common AA defences during WWI included 3-inch, 75 millimetre, 6-pounder and 1-pounder guns. Many of these guns were mobile, being mounted on lorry chassis. They were driven about following the course of an airship and fired from any area of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although more typically fell within 10km.



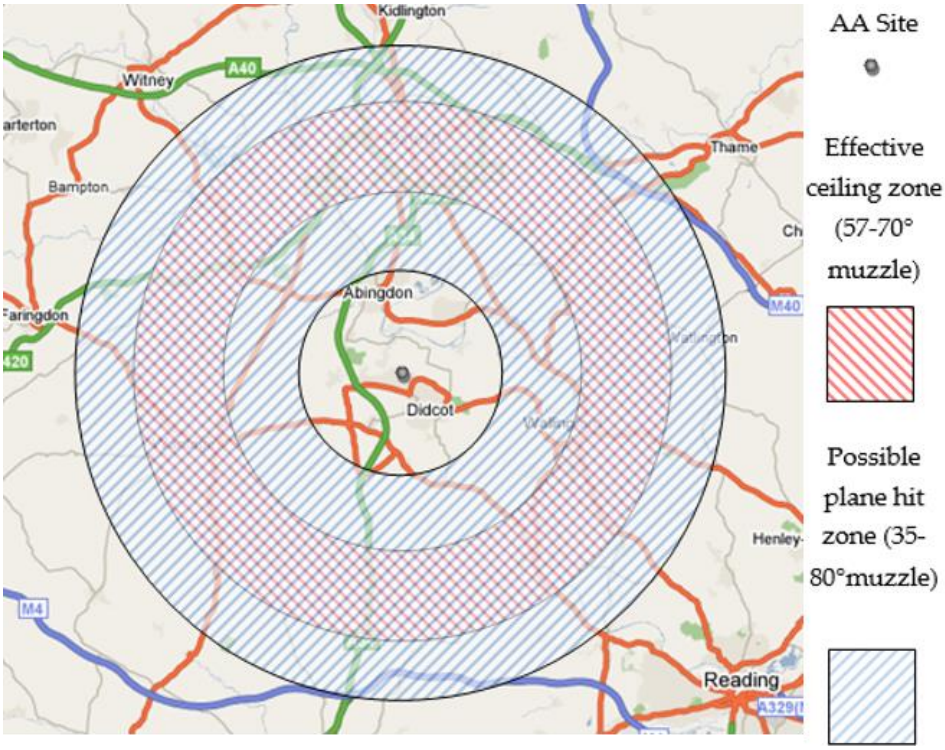
AA gun batteries were used extensively during WWII to counter the threat posed by enemy aircraft. In many instances, AA shells caused damage to Allied territory and in some areas caused significant numbers of civilian fatalities.

During WWII, AA shells could land up to 27km from the firing point, although more typically fell within 15km. These could be distributed over a wide area.

3No. types of AA batteries existed:

- **Heavy Anti-Aircraft (HAA)** batteries of large guns (typically 3.7", 4.5" and 5.25" calibre) designed to engage high flying bomber aircraft. These tended to be relatively permanent gun emplacements.
- **Light Anti-Aircraft (LAA)** weaponry, designed to counter low flying aircraft. These were often mobile and were moved periodically to new locations around strategic targets such as airfields. They typically fired 40mm shells and machine gun ammunition.
- **Rocket batteries (ZAA)** firing 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km were typically permanent emplacements.

Unexploded AA (UXAA) shells were a common occurrence during WWII. As the figure below demonstrates, shells were unlikely to fall in the immediate vicinity of a gun battery but in the surrounding area. This would be dependent upon the angle of fire and the flight height of the attacking aircraft.



AA batteries were deliberately targeted by the Luftwaffe and therefore areas surrounding a gun battery may have a greater risk of UXB being present.

Munitions stores were also established around AA batteries. These stored the shells for the batteries and small arms ammunition for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

Appendix 2.4 Bombing Decoys

Bombing decoys were developed between 1940 and 1941, with the intention of creating false bombing targets that were realistic enough to divert enemy aircraft away from the authentic ones. The decoy system proved to be successful in many areas of the UK with at least 5% of the total weight of bombs drawn away from their intended targets. Approximately 729No. static bombing decoys were built at 593No. locations in the UK. Additionally, several temporary and mobile decoys were deployed.

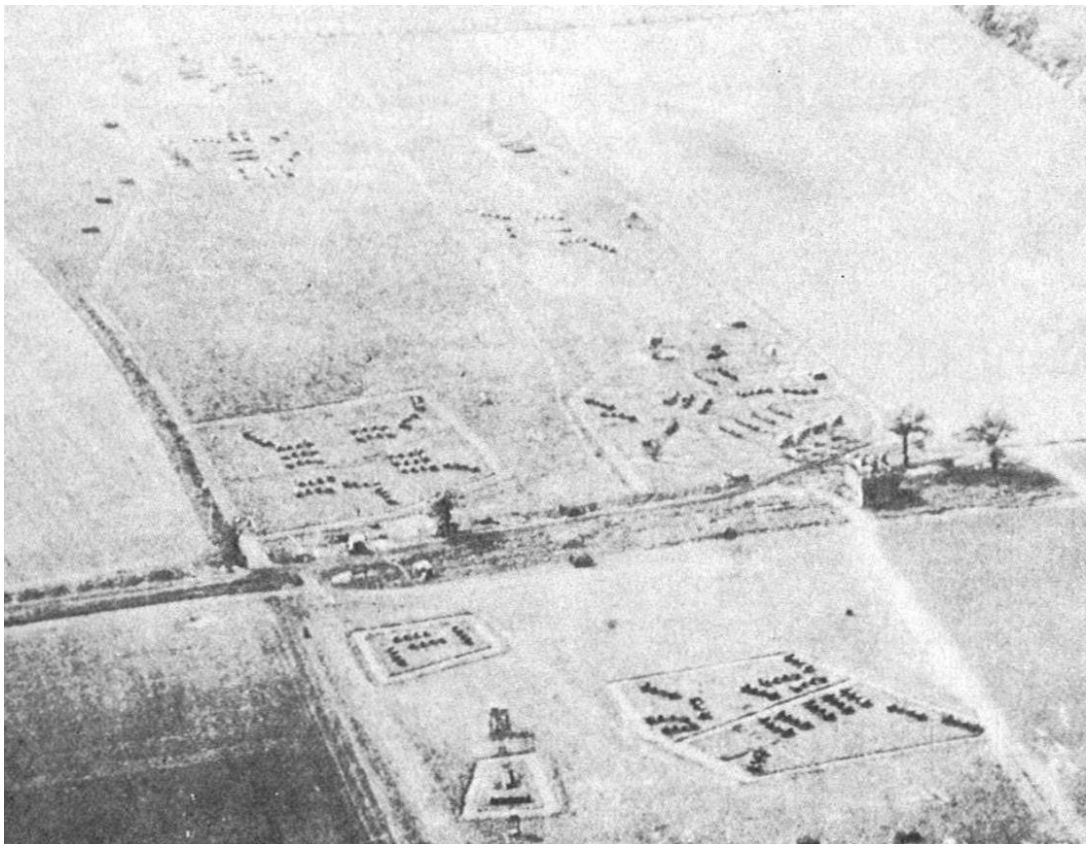
Several different types of decoy were devised:

Night time dummy airfields (Q sites).
Daytime dummy airfields (K sites).
Diversionary fires to simulate successful bombing raids on airfields (QF sites), petroleum depots (P sites) and major towns and cities (Starfish [SF] Sites).
Simulated urban lighting (QL sites).
Dummy Heavy Anti-Aircraft (HAA) batteries, factories and buildings (C series).
Mobile decoys representing 'hards' for troop embarkation (MQLs), tanks and other vehicles.

The country was divided into four areas:

'K1' referred to the area covering Scotland, Northumberland and Durham,
'K2' - Yorkshire and Lincolnshire
'K3' covering East Anglia and the counties to the west

'K4' encompassing the south-east of the country.



Dummy aircraft were recreated to add to the illusion that a real airfield was present. Flare paths and landing lights were simulated to conjure up the effect of an airfield at night.

'Q sites' received 359 attacks alone by the end of 1941, whilst the airfields they were detracting the enemy from were bombed 358 times. The 'K' and 'Q' sites were effective; between June and December 1940 there were 30 attacks on 'K' sites, 174 attacks on 'Q' sites and 23 against dummy factories.

The far bigger 'Starfish' decoys were developed in 1940. They were initially developed around Sheffield, Derby, Bristol, Birmingham, Coventry and Crewe and there were 18 sites by December 1940 (3 for each city). These decoys were typically comprised of a building-like timber/metal frame covered in hessian and packed with highly combustible material. They were designed to be used more than once. Between the 2nd December and 16th March 1941, 36 of these decoys were ignited. By the end of 1942 there were 209 Starfish and 168 'Q' site decoys. Machine gun emplacements and Light Anti-Aircraft (LAA) guns were used to prevent possible enemy landings at decoy airfields.

By their nature, bombing decoys provide a potential hazard from Unexploded Bombs (UXB), both within the decoy site boundary and in the surrounding areas.

Because bombing decoys were established on greenfield sites, many seemingly innocuous fields may have a potential UXB hazard. It is therefore crucial to check the existing database of bombing decoys to ensure that your site is not affected.

It is also key to understand whether any bombing decoy near your site was successful. Whilst many were attacked, some were not and therefore not all bombing decoy sites provide a UXB hazard.

Appendix 2.5 Marine Mines

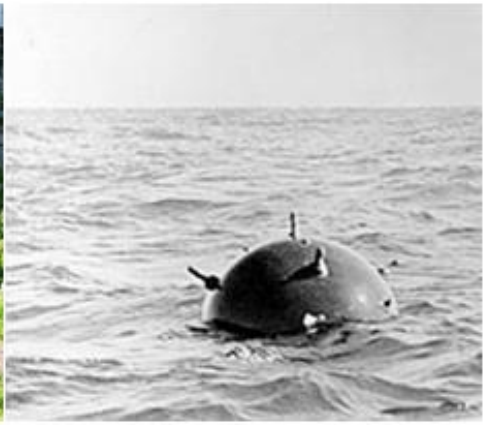
Marine mines have been used in some form since at least the 17th century, when gunpowder-filled kegs were deployed as a primitive naval weapon. Designs gradually improved until the 19th century when marine mines became widely used for coastal defence.

During WWI, approximately 128,000No. mines were laid in the sea around the coast of the UK. At the beginning of WWII, the Admiralty ordered the laying of further extensive minefields around the coast of England. This included both defensive mines on beaches in order to prevent enemy landings, as well as approximately 100,000No. marine mines laid at sea to destroy enemy ships. Some of these were buoyant and others were deployed by anchoring them to the seabed.

By WWII, marine mines typically carried 100 to 500lbs (50 to 250kg) of explosive. The initiating mechanisms in these mines have often deteriorated but the explosive charges will not have significantly altered unless the mine has split and the explosives have migrated and dispersed in the marine environment.

German aircraft also dropped thousands of magnetic mines into shipping lanes and estuaries. Many of these were removed by British minesweepers, although outside the major shipping lanes the requirement for disposal would have been reduced.





It is generally accepted that less than 30% of the total number of marine mines laid during WWII were recovered due to migration from their initial locations in tidal currents. The recovery rate for anchored submerged mines is likely to be higher but accurate records regarding the clearance of these minefields is not readily available.

As a result there is a possibility that some remain in the marine environment and a mine can be washed up on a beach or found drifting in the water around any part of the UK's coastline.

Appendix 3 Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

It is still important to note that explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay or similar materials.

The effects of an accidental UXO detonation are usually extremely fast, often catastrophic and invariably traumatic to any personnel involved. Such occurrences are largely restricted to current theatres of war and overseas minefields, with occasional events in mainland Europe.

Zetica, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly-recorded discoveries do also occur regularly, as demonstrated by the list of recent significant UXO finds in the UK below. To keep up to date with the latest UXO finds, visit http://[redacted]news/.

On the 3rd February 2020, a 500kg German UXB was found on a building site in Soho, London. It was removed by an EOD team.

On the 18th April 2020, a 500lb British UXB was discovered by a farmer near Drayton in Oxfordshire. The area had been used as an RAF practice bombing range during WWII and after an in-situ disposal was completed the item was found to have contained no explosives.

On the 4th May 2020, a UXB was discovered by builders at Kings Hill on the former RAF West Malling airfield, the fourth found since 2017. It was destroyed in a controlled explosion.

On the 1st December 2020, a research vessel discovered an unexploded marine mine containing 350kg of explosives in Wemyss Bay in the Firth of Clyde. RN divers investigated the item and destroyed it.

On the 4th February, 2No. anti-tank mines were discovered on Slapton Sands in Devon. They had been uncovered by recent storms and were destroyed.

On the 26th February 2021, a 1,000kg German “Hermann” UXB was discovered by builders at Exeter University campus (see plate below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 10th May 2021, 1No. Anti-Aircraft shell dating from WWII was found by a member of the public in Horsham, Surrey. It was destroyed in-situ by a bomb disposal unit.

On the 17th May 2021, 1No. Sea Wolf missile was brought onboard a fishing vessel near Brixham in Devon. A Royal Navy EOC team destroyed the missile in a controlled explosion.

On the 1st June 2021, a cache of approximaetly 100No. hand grenades dating from WWII were found in a Nottinghamshire forest, a possible relic from nearby wartime camps. They were destroyed.

On the 23rd July 2021, 1No. 18lb artillery shell dating from WWI was discovered in a private garden in Bloxham, Oxfordshire. It was transported to a nearby field where it was destroyed in a controlled explosion.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and then destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortars which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.

On the 18th October, 1No. 18.5lb artillery shell was discovered during the clearing-out of a farmyard barn near Aberfeldy in Perthshire. The shell dated from WWI and was removed.

On the 12th November 2021, 1No. unexploded artillery shell was found on a housing development site in Wrexham, Wales. It was detroyed in controled explosion.

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 15th December 2021, 1No. apparent UXB was snagged by a fishing trawler off the Norfolk Coast and then detonated, causing significant damage to the vessel. Upon further investigation, it was concluded that the UXB had been dropped in the water during WWII.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 17th February 2022, 1No. WWI-era Mk1 Mills hand grenade was found in the River Frome in Dorset by magnet fishermen. This was the third grenade to be pulled from the same stretch of the river over the past year. After an inspection by local police, the grenade was removed by an EOC team and destroyed.

Appendix 4 Glossary and Definitions

Abandoned Explosive Ordnance (AXO)	Abandoned Explosive Ordnance is explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Close Combat Munitions	Items of ordnance thrown, propelled or placed during land warfare, to include grenades, mortars, projectiles, rockets and land mines.
Demil	Derived from the term 'Demilitarisation', it refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame and a shock wave.
Device	This term is used for any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells or bombs.
Explosive	The term explosive refers to compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat and pressure. Obviously, these are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	Explosive Ordnance is all munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads, guided and ballistic missiles, artillery, mortar, rocket, small arms ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs & dispensers, cartridge & propellant actuated devices, electro-explosive devices, clandestine & improvised explosive devices, and all similar or related items or components explosive in nature.
Explosive Ordnance Clearance (EOC)	Explosive Ordnance Clearance is a term used to describe the operation of ordnance detection, investigation, identification and removal, with EOD being a separate operation.
Explosive Ordnance Disposal (EOD)	Explosive Ordnance Disposal is the detection, identification, on-site evaluation, rendering safe, recovery and final disposal of unexploded explosive ordnance.
Explosive Ordnance Reconnaissance (EOR)	Explosive Ordnance Reconnaissance is the detection, identification and on-site evaluation of unexploded explosive ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Explosive Remnants of War are Unexploded Ordnance (UXO) and Abandoned Explosive Ordnance (AXO), excluding landmines.

Explosive Substances and Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture of substances), which are either: • capable by chemical reaction in itself of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. • designed to produce an effect by heat, light, sound, gas or smoke, or a combination of these as a result of a non-detonative, self-sustaining, exothermic reaction. Explosive article is an article containing one or more explosive substances.
Fuze	A fuze is the part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and in particular in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A geophysical survey is essentially a range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance as disturbance of ordnance items is to be avoided where ever possible.
Gold line	This is the estimated limit of blast damage from an explosive storage magazine. It usually means that development within this zone is restricted.
High Explosive	Secondary explosives (commonly known as High Explosives (HE)) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are: Nitro glycerine (NG), Trinitrotoluene (TNT), AMATOL (Ammonia nitrate + TNT), Gunpowder (GP), and Cyclotrimethylenetrinitramine (RDX).
Munition	Munition is the complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions. This includes those munitions that have been suitably modified for use in training, ceremonial or non-operational purposes. These fall into three distinct categories:- • inert - contain no explosives whatsoever. • live - contain explosives and have not been fired. • blind - have fired but failed to function as intended.

Primary Explosive	Primary explosives are usually extremely sensitive to friction, heat, and pressure. These are used to initiate less sensitive explosives. Examples of primary explosives are: Lead Azide, Lead Styphnate, and Mercury Fulminate. Primary explosive are commonly found in detonators.
Propellants	Propellants provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are: Ballistite often found in a flake form and Cordite used in small arms ammunition.
Pyrotechnic	A pyrotechnic is an explosive article or substance designed to produce an effect by heat, light, sound, gas or smoke, or a combination of any of these, as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	SAA includes projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns and machine guns.
Unexploded Anti-Aircraft (UXAA) Shell	UXAA shells are army ordnance commonly containing HE, though they can also contain pyrotechnic compounds that produce smoke. Most commonly, these were 3.7” and 4.5” HE shells, although they ranged from 2” to 5.25” calibre.
Unexploded Bomb (UXB)	UXB is a common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	UXO is explosive ordnance that has been either primed, fuzed, armed or prepared for use and has been subsequently fired, dropped, launched, projected or placed in such a manner as to present a hazard to operations, persons or objects and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, V-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Buzz Bomb or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 (V-2) (‘Reprisal Weapon 2’) was the first ballistic missile. It was used by the German Army primarily against Belgian and British targets during the later stages of WWII. The V-2 was the first man-made object launched into space, during test flights that reached an altitude of 189km (117 miles) in 1944.

Appendix 5 [redacted] Incident List

30th October 1940

1No. HE bomb fell on Southmere, Havant, approximately 0.3km east of the Site.

5th December 1940

Several HEs bombs fell in Langstone Harbour, in the vicinity of the Site.

15th January 1941

1No. DAB fell in Langstone Harbour, south of Bedhampton Mill, on the Site.

10th March 1941

4No. HE bombs fell near Langstone Bridge, approximately 0.5km southeast of the Site.

11th March 1941

1No. HE bomb fell in the searchlight field at Langstone Road, Havant, approximately 0.4km east of the Site.

11th April 1941

8No. HE bombs fell in Langstone Harbour, between Farlington and Langstone Bridge, within approximately 0.3km south of the Site.

5th June 1941

1No. HE bomb fell in the north end of Langstone Harbour, on the Site.

9th June 1941

2No. HE bombs fell in Langstone Harbour, near Binness Island, within approximately 0.3km south of the Site.

21st August 1942

4No. HE bombs fell on Ranelagh Road, approximately 0.3km north of the Site.

6th August 1943

Several IBs fell in a field behind the waterworks on Brockhampton Road, approximately 0.1km northeast of the Site.

15th August 1943

2No. HE bombs fell in the sea off Farlington Marshes, approximately 0.1km east of the Site.

3No. HE bombs fell on the foreshore near Forty Acre Farm, approximately 0.3km west of the Site.

Approximately 40No. HE bombs fell in Langstone Harbour, in the vicinity of the Site.

16th August 1943

Several IBs fell across Broad Marsh, on the Site.

1No. OB and several IBs fell in a field behind waterworks on Brockhampton Road, approximately 0.1km northeast of the Site.

26th April 1944

At least 8No. HE bombs fell in Langstone Harbour, near Baker Island, in the vicinity of the Site.

15th May 1944

At least 22No. HE bombs fell in Langstone Harbour, in the vicinity of the Site.

Appendix 6 UXO Migration in the Marine Environment

The factors controlling UXO migration in the marine environment surrounding the Site are discussed below.

Tidal Currents

Langstone Harbour is part of a tidal inlet system which receives freshwater inputs from a few minor tributaries. The harbour is considered to be tidally dominated, with a tidal range of 0.1m to 5.2m.

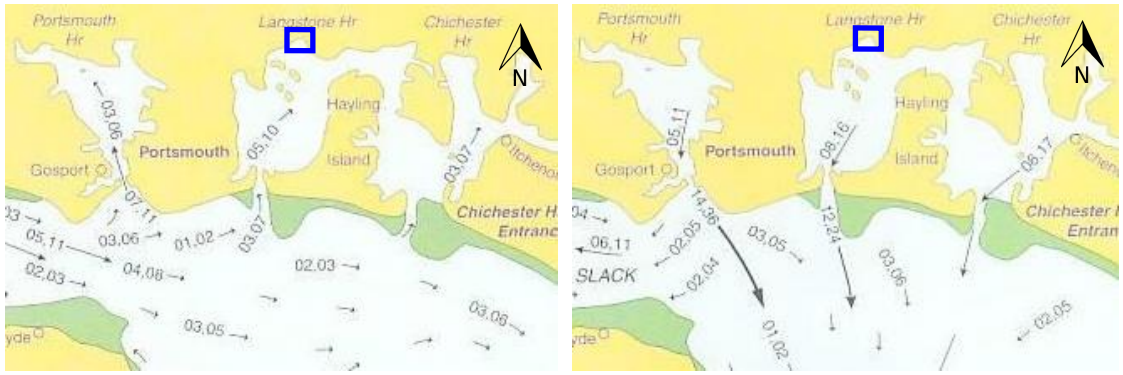
Langstone Channel, in the vicinity of the Site, consists of a deep trench, maintained by strong tidal currents and dredging. The predominant current is the ebb flow, which results in water leaving the inlet moving faster than water entering it.

Tidal currents in the Langstone Channel generally have maximum spring tide flood velocities of 0.9ms^{-1}, and ebb velocities of 1.8ms^{-1}. The narrow outlet of Langstone Harbour confines the tidal flow of large volumes of water into and out of the harbour, setting up strong tidal currents which extend several kilometres offshore. Residual current speeds are in the order of 0.15-0.16ms^{-1}.

Flood flow is primarily north-eastward and ebb flow south-westward.

Typical tidal streams are shown in Figure 8.

Figure 8 Typical tidal streams for flood and ebb flows in the vicinity of the Site



Source: Tidal Stream Atlas *Not to Scale*

Legend	Site boundary

The Langstone Channel splits into a number of smaller channels in close proximity to and encroaching onto the Site, notably the Broom Channel, Mallard Lake and Russell's Lake, to the west, south and east of the Site, respectively.

Offshore tidal streams are controlled mostly by channel geomorphology and water depth. Peak near and offshore velocities are highest in deeper water. However, tidal variants exist throughout Langstone Harbour due to the shallow mud flats covering the majority of the basin.

In the vicinity of the Site tidal currents offshore are broadly aligned with the channel and bank system in the Broom Channel, Mallard Lake and Russell's Lake, with large expanses of mud flats, salt marshes, shingle banks and sand banks exposed at low water.

Wave Action

Wave data demonstrates that the wave environment in Langstone Harbour is predominantly wind driven. Ship-generated waves are limited in the vicinity of the Site, particularly as shipping is restricted to a maximum speed of 10 knots when passing through the Langstone Channel.

The combination of a short fetch in Langstone Harbour with the shallow mud flats surrounding the Site produces small, high frequency waves. In contrast, the wave heights for Langstone Harbour Entrance are measured between 2.1m and 2.6m.

South of the Site, the prevailing wave direction in the Solent is from the southwest, although under the right circumstances a significant amount of wave energy can also approach from the south and south-east.

Waves entering Langstone Channel from the Solent are restricted by the narrow channel and the presence of the Langstone Bar, and so waves generated outside cannot penetrate far into the harbour. In the vicinity of the Site, the coastline is protected from direct wave action, although extreme sea levels and wave heights can occur during storm surges.

Tidal currents are the major mechanism for sediment movement and wave action is relatively insignificant due to limited fetch.

Sediment Pathways

The low cliffs south of Stoke, on the west coast of Hayling Island, are subject to shallow slumping and provide a small sediment yield.

Erosion monitoring between 1988-1996 on North Binness and Long Islands, encroaching onto the Site, also revealed some active wave abrasion of shore platforms and cliff retreat at a mean rate of $0.34ma^{-1}$.

The sedimentary material transported by a combination of tidal currents and wave action in the vicinity of the Site averages approximately $1,000m^3a^{-1}$.

The presence of the Langstone Bar, and the East and West Winner banks at the mouth of the Langstone Channel indicates that some sedimentary materials are transported southwards from the Harbour due to tidal action.

The average transport capacity heading north through the Langstone Channel has been calculated at 22×10^9 kg a^{-1}.

The sediments deposited range from gravels and sands at the harbour entrance (high energy conditions) to fine silts and clays at the estuary head and adjacent to tidal channels (very low energy conditions), such as those adjacent to and encroaching onto the southern part of the Site.

Net bedload transport of coarse sands and gravels is dominantly seaward at the harbour entrance, forming extensive part-submerged coarse sand and gravel delta deposits immediately offshore.

Input of coarse sediment is only possible when spring flood tides coincide with southerly storms, so that a combination of tidal and wave driven currents transport this size range of material too far into the harbour for their re-entrainment by the ebb tidal stream. This periodic "pulsed" input accounts for the accumulation of coarse sandy sediments on Sword and Sinah Sands, to the south of the Site.

A survey of sand waves on Sword Sands, approximately 3.3km south-southwest of the Site, suggests bedload sand transport close to the harbour entrance. Measurements indicate transport is northward in the centre of the bank and southward along the edges. Sword Sands include a proportion of coarser material such as boulders, pebbles and shell debris.

Mallard Sands, in the immediate vicinity of the Site, are the furthest from the entrance and comprise the finest sediments, mostly sandy mud.

Channel sediments are much coarser and less well sorted than adjacent mudflats which in turn become finer and better sorted further north and away from the main tidal channels.

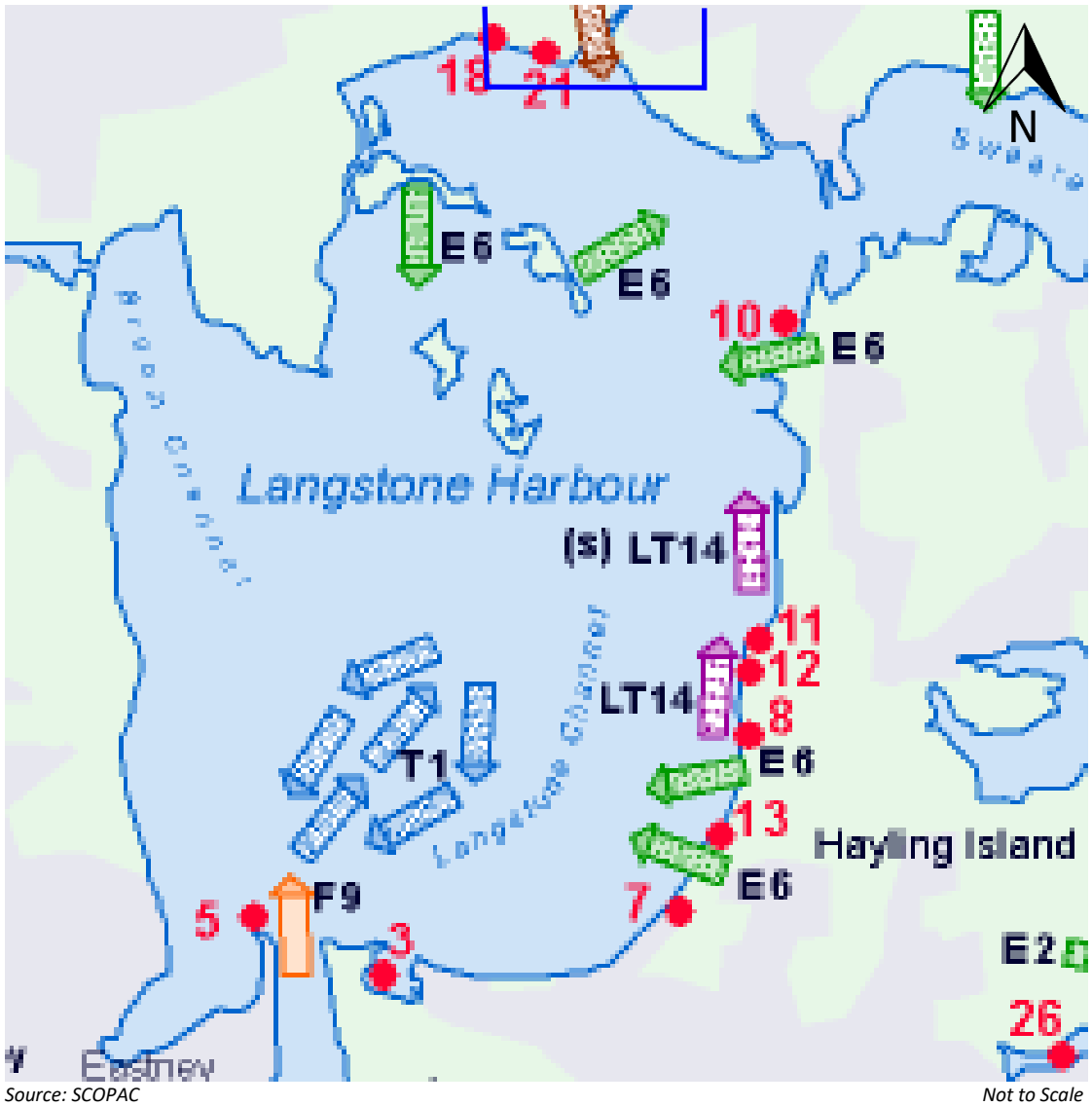
The contrast between the velocities of ebb and flood tidal streams at Langstone Harbour entrance is such that net transport of suspended sediment (fine sands, silts, clays and organic particles) is into the harbour and once inside they tend to accumulate there.

The mudflats represent a long-term net accretion of material that is deposited from suspension during slack water.

Langstone Harbour may be gaining between 17 and 34 x $10^3 m^3$ of intertidal mudflat sediment annually.

Figure 9 summarises the offshore net sediment pathways in the vicinity of the Site.

Figure 9 Offshore net sediment pathways in the vicinity of the Site



Source: SCOPAC *Not to Scale*

Legend	Site boundary	Wave driven nearshore and offshore zone transport
	Littoral (beach) drift	Cliff/slope erosion
	Fluvial input	Tidal driven

Dredging

Langstone Channel has been dredged for navigational purposes since the late 19th century.

Dredging at the entrance to Langstone Harbour significantly increases the concentration of suspended sediment, causing increased short-term input during the flood tide. A survey of dredging activity in the 1960s and 1970s concluded that roughly 56,000 tonnes per year of suspended sediment had been introduced into the area around the Langstone Bar.

Between 1987 and 1997, 143,190 tonnes of sediment were dredged from Langstone Harbour and its approaches.

In addition to the dredging of Langstone Channel, Sinah Sands, within approximately 3.8km south-southwest of the Site, was periodically dredged until 1995. Anecdotal evidence suggests that this dredging amounted to 'several thousand tonnes' per annum.

The harbour entrance channel, Langstone Channel (up to Bedhampton) and Broom Channel, within approximately 2km southwest of the Site, are currently dredged for navigational purposes.

Appendix 7 Bibliography

Bulloch G, Steeds J E , Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S, & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German aerial Photography 1939-1942, 1996

Clarke N J, Adolf's British Holiday Snaps: Luftwaffe Aerial Reconnaissance Photographs of England, Scotland and Wales, 2012

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994.

Dobinson C S, Twentieth Century Fortifications in England, Volume I 1, Anti-aircraft artillery, England's air defence gun sites. 1914 – 46. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 2, Anti-aircraft artillery, Site gazetteer, WWI. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I. 3. Anti-aircraft artillery, 1914-46, Site gazetteer, WWII HAA & ZAA. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 4, Anti-aircraft artillery, Site gazetteer, WWII LAA. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 5, Anti-aircraft artillery, Sources. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume II, Anti-invasion defences of WWII. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume III, Bombing decoys of WWII, England's passive air defence 1939-45. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume VIII, Civil defence in WWII, Protecting England's Civil Population. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Supporting paper AA/1 Searchlight sites in WWII. Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Easthope W G, Smitten City: The Story of Portsmouth under Blitz, 1981

Fegan T, The Baby Killers, 2002

Leete J, In Time of War Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Peake N, City at War: a pictorial memento of Portsmouth, Gosport, Fareham, Havant and Chichester during World War II, 1986

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Triggs A, Portsmouth, a Shattered City, 2003

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

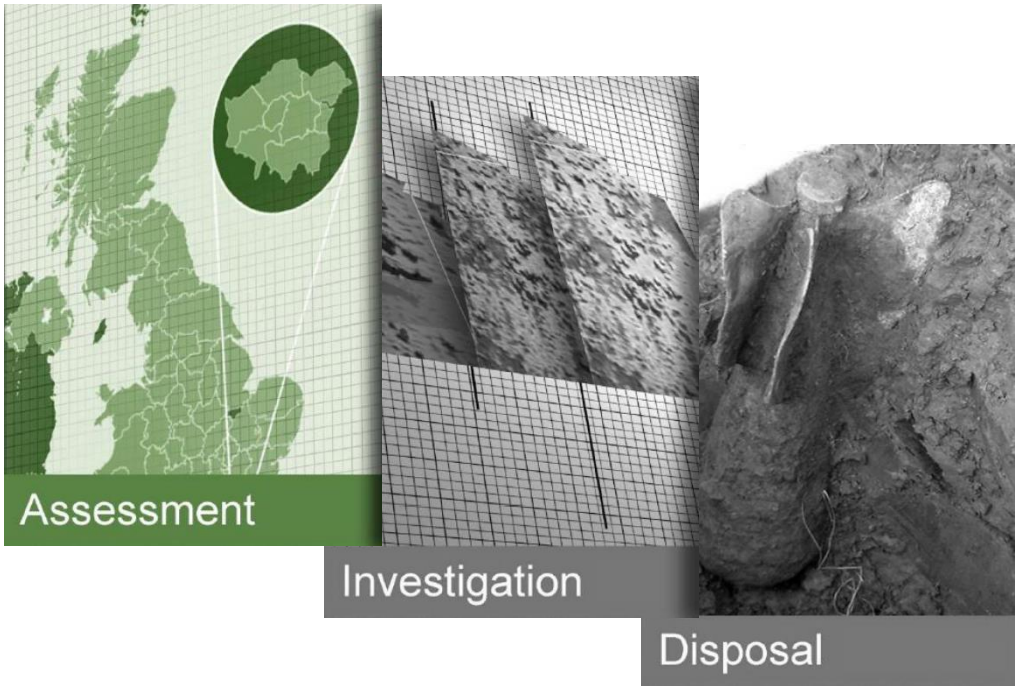
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- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]


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Budds Farm WTW, Havant - UXO Desk Study & Risk Assessment

Document Title	**UXO Desk Study & Risk Assessment**
Document Ref.	**P6662-17-R1**
Revision	**A**
Project Location	**Budds Farm WTW, Havant**
Client	**Southern Water**
Date	**8th February 2017**

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UXO DESK STUDY & RISK ASSESSMENT

Budds Farm WTW, Havant

EXECUTIVE SUMMARY

Zetica Ltd was commissioned by Southern Water to carry out an Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an area of approximately 21.5 hectares (ha) at Budds Farm Water Treatment Works (WTW), Havant, Hampshire ('the Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 8 in the main report.

Figure	UXO hazard zone plan of the Site



Source: Google Earth *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- No records of bombing or military activity on the Site during World War One (WWI) have been found.
- During World War Two (WWII) the main strategic targets in the vicinity of the Site included military camps and training facilities, aircraft manufacturers, and major transport infrastructure.
- During WWII the Site was located in the Urban District (UD) of Havant and Waterloo, which officially recorded a moderate regional bombing density.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bombs fell within approximately 0.5km from the Site.
- No significant post-WWII military activity is recorded on the Site.

The Table below, reproduced as Table 5 in the main report, provides a UXO risk assessment for potential work on the Site.

Further details on the methodology for the risk assessment are provided in Section 11.1 of the main report.

Table UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Shallow Excavations	1	1	1	1	5	5	Low
	Deep Excavations	1	1	1	1	5	5	Low
	Piling/boreholes	1	1	1	1	4	4	Low
Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
	Deep Excavations	1	1	1	1	4	4	Low
	Piling/boreholes	1	1	1	1	3	3	Low

PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)

Shallow excavations defined as <1.0m below ground level (bgl).

Risk Mitigation Recommendations

To ensure that the UXO risk is reduced to As Low As Reasonably Practicable (ALARP) the following mitigation is advised:

Where a low risk of UXO encounter is anticipated, industry good practice is simply to raise the awareness of those involved in excavations so that in the unlikely event that a suspect item is discovered, appropriate action is taken. This can be achieved through UXO awareness briefings to site staff.

Clearance certification for borehole or pile locations is considered prudent only if a zero tolerance to risk is adopted. Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.

Table 6 in the main report gives recommended actions in relation to the potential UXO risk level and the anticipated Site activity.

Further advice on the mitigation methods can be provided by Zetica on request.

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UXO DESK STUDY & RISK ASSESSMENT

Budds Farm WTW, Havant

Note: To aid the reader of this report, Zetica has colour coded each paragraph. Paragraphs with black text on a white background are paragraphs that provide site-specific information or information specifically researched as part of this project.

Paragraphs in a dark green text with a green background are paragraphs containing background information or explanations which may appear as standard text in all similar reports.

1 INTRODUCTION

1.1 Project Outline

Zetica Ltd was commissioned by Southern Water to carry out an Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an area of approximately 21.5 hectares (ha) at Budds Farm Water Treatment Works (WTW), Havant, Hampshire ('the Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

This hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance (UXO).
- Probable location.
- Ordnance condition.

It is essential to note that the effects of military activity will often extend beyond the source of the activity. For example, a base for armed forces may use surrounding areas of open land outside the official or recorded military boundaries for practice and military related activities.

In addition, World War One (WWI) and World War Two (WWII) aerial bombardment was not discrete. 'Pinpoint' targeting did not exist in WWI or WWII. The effects of bombardment would be apparent in areas around the intended target.

It is for these reasons that it is important to address military activity both on the Site and in the relevant surrounding areas.

It should be noted that some military activity providing a source of UXO hazard may not be readily identifiable and therefore there cannot be any guarantee that all UXO hazards on the Site have been identified in this report.

1.2 The Site

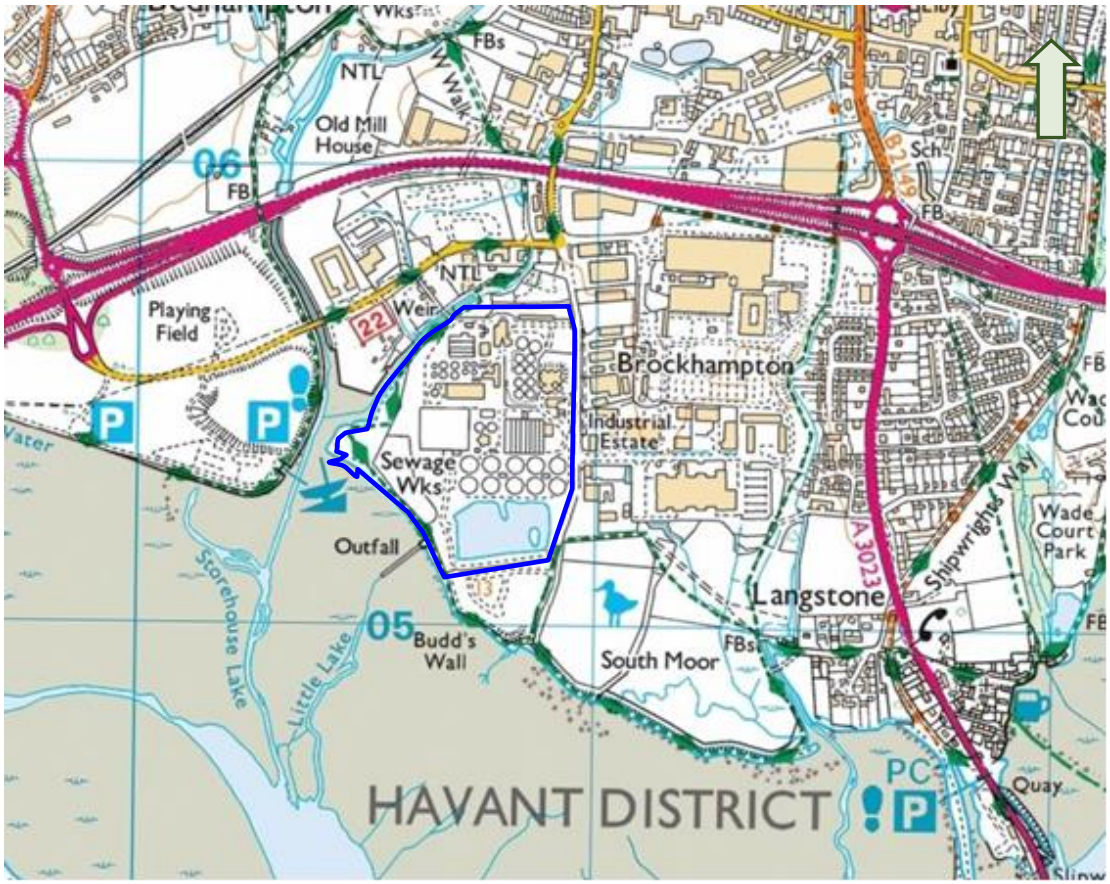
The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU 707054. It is located in Brockhampton, approximately 1km southwest of Havant town centre.

The Site comprises Budds Farm Water Treatment Works (WTW). It is bounded to the north by a car park and industrial depot, by Southmoor Lane to the east, an area of open land to the south, and to the west by Solent Way.

It is understood that planned works on the Site may include intrusive ground investigations and excavations.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1	Site location map



Source: © Crown Copyright 2017. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1	Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

2 SOURCES OF INFORMATION

2.1 Historical Information

With most locations, the potential presence of UXO as a result of enemy action, unauthorised disposal or unrecorded military activity can never be totally discounted.

Detailed records of military activity are rarely released into the public domain. Even when military information is made public there may be gaps in the records because files have been lost or destroyed.

Records for periods such as WWII are only as detailed and accurate as the resources and working conditions would allow at the time. Densely populated areas tend to have a greater number of records than rural areas. Such records may be inaccurate due to the confusion surrounding continuous air raids.

Press records can supplement local information, although this source of information must be treated with caution, as inaccuracies do exist, either inadvertently or intentionally in order to confuse enemy intelligence. Classified official records can sometimes be considered inaccurate for the same reason.

Recent research indicates that England alone had 17,434No. recorded defence sites, of which 12,464No. were classified as defensive anti-invasion sites. The precise locations of many of these sites are still to be identified, illustrating the scale of the problem when establishing potential risks from limited historical data.

Zetica Ltd researched the military history of the Site and its surrounding area utilising a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

2.2 Zetica Ltd Defence Related Site Records

Zetica Ltd's in-house records were consulted, including reference books and archived materials from past work in the region. Relevant documents have been cited within the bibliography of this report.

2.3 Zetica Ltd Bombing Density Records and Maps

Reference has been made to the Zetica Ltd bomb risk maps located on ZeticaUXO's website (http://[redacted]downloads-and-resources/risk-maps).

2.4 Ministry of Defence and Government Records

Various government departments and units within the Ministry of Defence (MoD) were approached for information of past and present military activity in the area. These included the Home Office records of abandoned bombs.

2.5 Other Historical Records, Maps and Drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, Historic England and the Defence of Britain Project.

The British Geological Survey (BGS) was consulted for borehole information.

The British Geological Survey (BGS) was consulted for borehole information.
2.6 Local Authority Records
Information has been obtained from Hampshire County Council.
2.7 Local Record Offices and Libraries
Hampshire Record Office was consulted for information.
2.8 Local Historical and Other Groups
Local history groups and archaeological bodies were consulted, including the Hampshire Historic Environment (HER) Record.
2.9 Data Confidence Level
In general, there is a high level of confidence in the researched information sources used for this report. Any exceptions to this are specifically detailed in the text of this report.

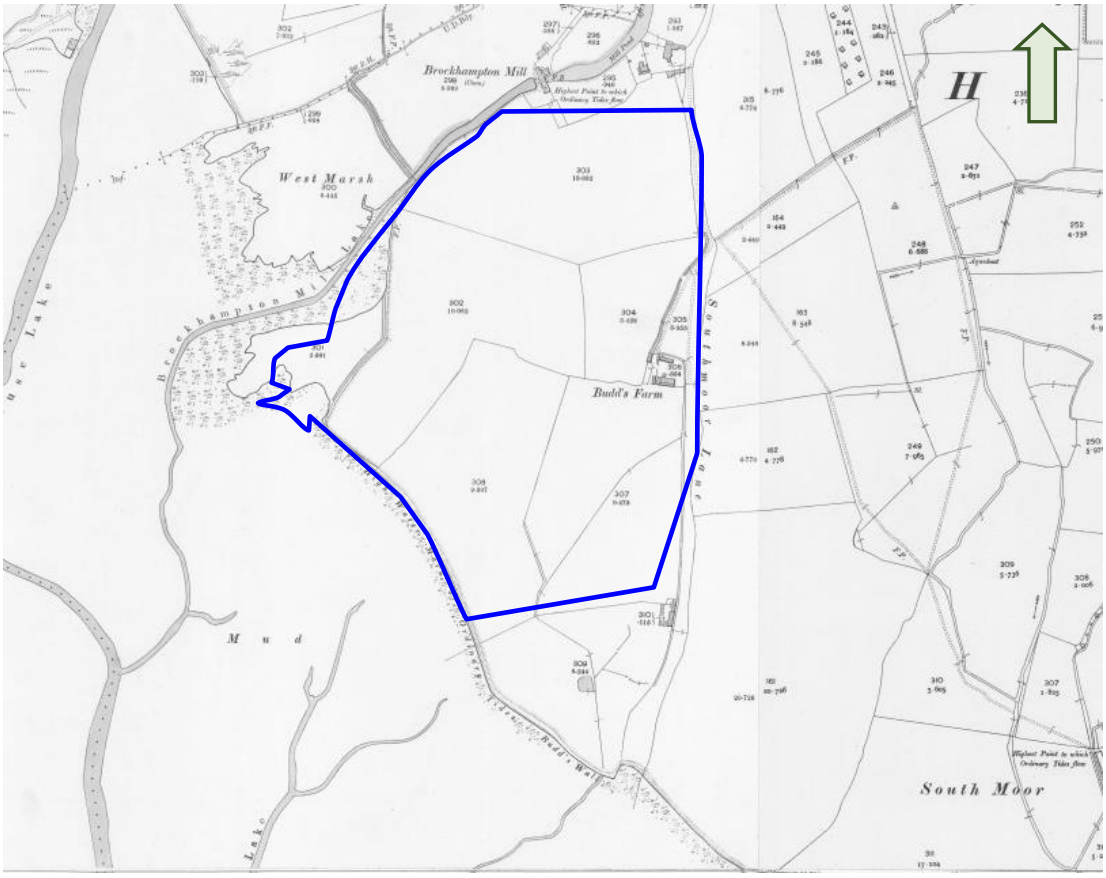
3 SITE HISTORY

3.1 General History

The historical map of 1897 (Figure 2) shows that at the end of the 19th century the Site comprised Budds Farm and surrounding fields. Brockhampton Mill and its weir were located to the north of the Site.

The surrounding area remained predominantly rural.

Figure 2	Historical map, 1897

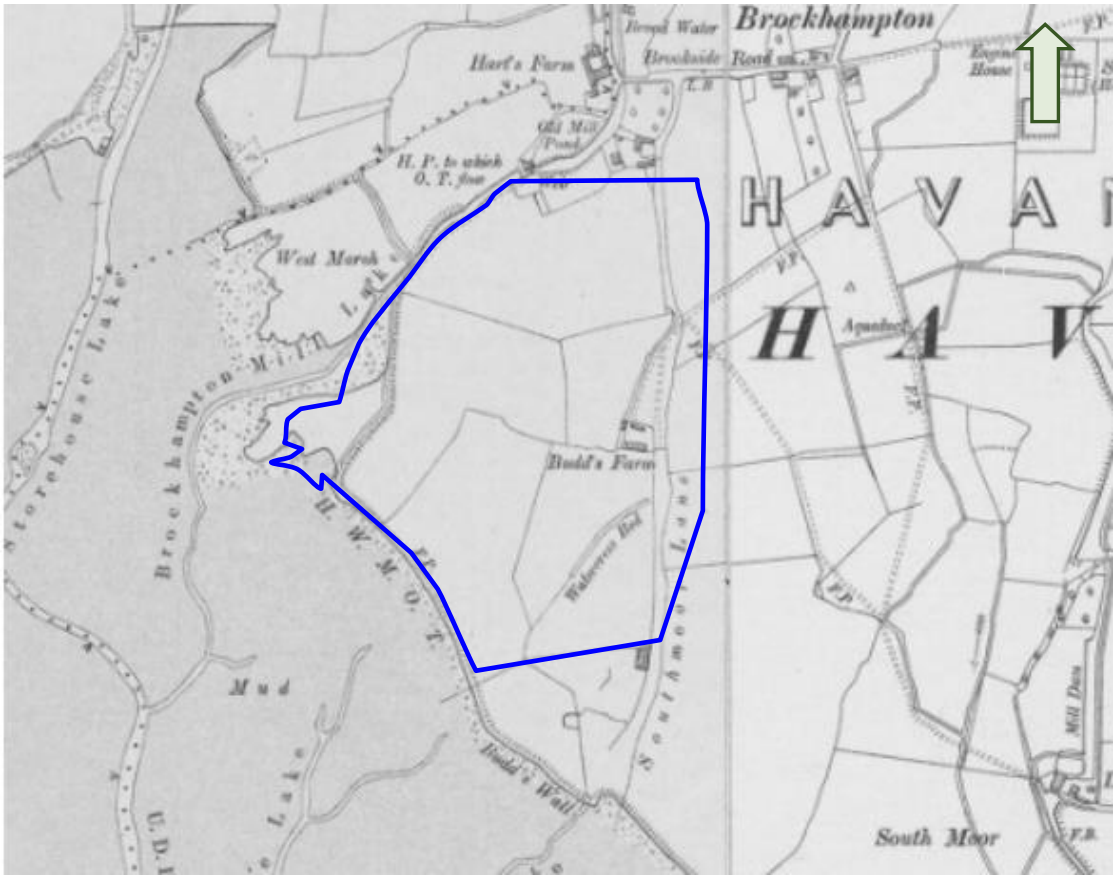


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Legend	Site boundary

The historical map of 1910 (Figure 3) shows that a watercress bed had been established on the Site. A small building had also been constructed to the south of the Site.

Figure 3	Historical map, 1910

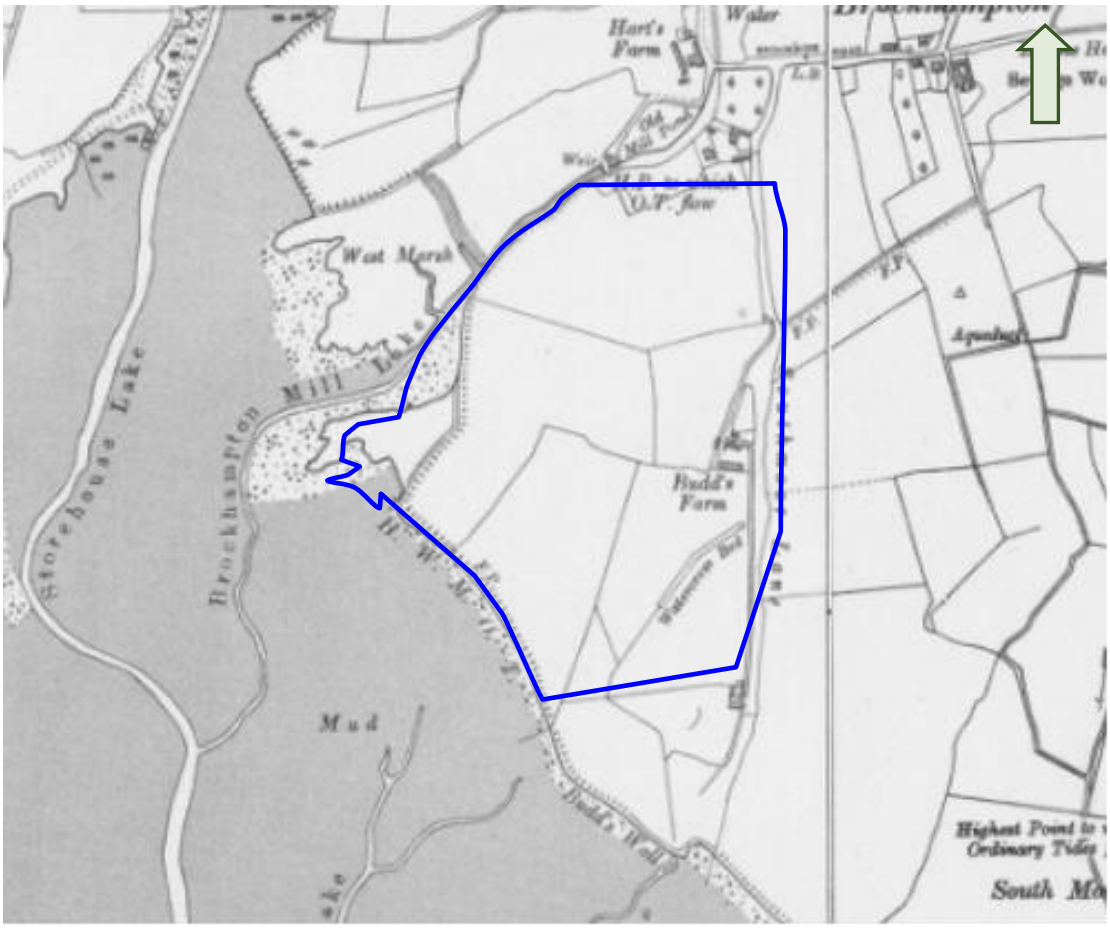


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Legend	Site boundary

The historical map of 1933 (Figure 4) shows that prior to WWII the Site remained unchanged.

Figure 4	Historical map, 1933



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Legend	Site boundary

Plate 2, an aerial photograph dated the 5th November 1960, shows that a sewage works had been built on the Site. The surrounding area remained largely undeveloped.

Plate 2	Aerial photograph, 5th November 1960



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 3, an aerial photograph dating from 1993, shows that the sewage works had been extended across the Site.

Industrial estates had been constructed on land to the north and east of the Site.

Plate 3	Aerial photograph, 1993



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 4, an aerial photograph dating from 2007, shows that further extension to the sewage works on the Site had occurred.

The industrial estates surrounding the Site had also been enlarged

Plate 4	Aerial photograph, 2007



Source: Google Earth *Not to scale*

Legend	Site boundary

Since 2007 there has been no significant development on the Site (see Plate 1).

3.2 Pre-WWI Military Activity

No records of any significant pre-WWI military activity on or in close proximity to the Site have been found.

3.3 WWI Military Activity

No records of any significant WWI military activity on or in close proximity to the Site have been found.

Farlington Racecourse, approximately 2.9km west of the Site, was used as an ammunition dump.

During WWI an estimated 9,000No. German bombs were dropped over Britain. It was the first time that strategic aerial bombing had been used.

The Site was located in a predominantly rural area with few significant strategic targets. The main target in the region was Portsmouth Naval Dockyard, more than 5km from the Site.

No records have been found indicating that the Site was bombed during WWI.

In response to the air raids, Anti-Aircraft (AA) guns were established. These were potential sources of Unexploded AA (UXAA) shells which could land up to 13km from the firing point, although more typically fell within 10km during WWI.

Records indicate that the Site was within the range of at least 12No. static HAA gun batteries during WWI. The nearest was located at Fort Purbrook (SU 678064), approximately 2.9km northwest of the Site. This was armed with 1No. 18 pounder (-pdr) gun.

WWI military activity is not considered to provide a source of UXO hazard to the Site.

3.4 WWII Military Activity

The Site was located in the vicinity of several strategic targets, and bombing overspill from raids on Portsmouth occurred in the Havant area. Details for air raid incidents in the vicinity of the Site are provided in Section 4.

Numerous defence and offensive military structures were built in the vicinity of the Site. These included lines of defence (Stop Lines), pillboxes, bombing decoys and AA guns. Further details are given in Section 5.

Other military establishments in the vicinity of the Site are described in Sections 6 to 8.

3.5 Post-WWII Military Activity

No records of any significant post-WWII military activity on or in close proximity to the Site have been found.

4 [redacted]

Bombing raids began in the summer of 1940 and continued until the end of [redacted] densities generally increased towards major cities or strategic targets such as docks, industrial premises, power stations and airfields.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). The most common HE bombs were the 50kg and 250kg bombs, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped.

The HE bombs tended to contain about half of their weight in explosives and were fitted with one or sometimes two fuzes. Not all HE bombs were intended to explode on impact. Some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied bombs to a 250kg 'Oil Bomb' (OB) and a 500kg 'C300' IB. In some cases the IBs were fitted with a bursting charge. This exploded after the bomb had been alight for a few minutes causing burning debris to be scattered over a greater area. The C300 bombs were similar in appearance to 500kg HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineers to deal with their disposal.

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. 2No. types of anti-personnel bombs were in common use, the 2kg and the 12kg bomb. The 2kg bomb could inflict injury across an area up to 150m away from the impact, within 25m of this, death or fatal injury could occur.

PMs (which were up to 4m in length) could be detonated either magnetically or by noise/vibration. Anti-shipping parachute mines were commonly dropped over navigable rivers, dockland areas and coastlines. The Royal Navy was responsible for ensuring that the bombs were made safe. Removal and disposal was still the responsibility of the Bomb Disposal Unit of the Royal Engineers.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs which was aimed at a specific location might not just miss the intended target but fall some considerable distance away.

It is understood that the local Civil Defence authorities in urban areas had a comprehensive system for reporting bomb incidents and dealing with any UXO. In more rural areas, fewer bombing raids occurred. It is known that ARP records under-represent the number and frequency of bombs falling in rural and coastal areas.

Bombs were either released over targets or as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft fire or Allied fighter aircraft on the route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids on rural, river, marsh or coastal areas were often unrecorded or entered as 'fell in open country', 'fell in the sea' or 'fell in the river' and left little evidence of the fall.

4.1 Bombing in Portsmouth & South Hampshire

From 1939 the south coast of England was subjected to reconnaissance flights by the Luftwaffe. Strategic targets such as the Portsmouth Royal Dockyard were photographed and mapped in detail. From the onset of WWII, mine laying by the Luftwaffe along coasts and in estuaries such as the Solent and off Spithead became increasingly frequent.

Portsmouth was heavily bombed throughout WWII, being subjected to 67No. air raids in which in excess of 1,200No. HE bombs fell within Portsmouth CB. Bombing in Portsmouth was concentrated towards its naval base, despite the success of the decoys located in Langstone Harbour, designed to divert the Luftwaffe away from the city.

Raids near Havant began in August 1940 and continued until the end of WWII. These were largely the result of overspill from raids on Portsmouth or due to attacks on the bombing decoys in Langstone Harbour. From July 1941 the bombing campaign entered a period of relative inactivity until August 1943, when a heavy raid on Hayling Island occurred.

Manned bomber raids returned to the region in the first few months of 1944 and, after a brief respite, were followed by the start of the V1 (pilotless aircraft) offensive in June 1944. These weapons arrived at any time of day and caused massive blast damage (although little fire damage).

4.2 Strategic Targets

The presence of strategic targets significantly increased the likelihood of bombing within the local area. Airfields, docks, industrial facilities, transport infrastructure and anti-invasion defences were all targeted by Luftwaffe bombers. The inherent bombing inaccuracies at the time meant that areas surrounding the targets were often subjected to bombing.

The main strategic targets in the vicinity of the Site are described below.

4.2.1 Industrial Targets

A leather works on Solent Road, approximately 0.6km northeast of the Site, produced military clothing, including flying jackets and gloves.

Portsmouth Airfield was located approximately 3.8km southwest of the Site. This was the location of the Airspeed Limited manufacturing works, with the airfield used as a testing base for the training aircraft they produced.

4.2.2 Military Targets

West Leigh (SU 723079) and Leigh Park (SU 722089), located approximately 2.7km northeast and 3.5km north-northeast of the Site respectively, were requisitioned to establish HMS Vernon, a shore establishment used by the Mine Design Department.

Portsmouth Naval Base was located approximately 8.6km southwest of the Site. This was a major disembarkation point for troops travelling to the European mainland and included shipyards, barracks and training areas, as well as associated docks and wharves.

4.2.3 Transport Infrastructure

The Southern Railway (SR) mainline ran approximately 0.7km northwest of the Site and a branch line to Hayling Island ran approximately 0.9km east of the Site.

4.2.4 Public Utilities

Havant Sewage Works was located approximately 0.5km northwest and northeast of the Site.

Havant Water Works was located approximately 0.5km north of the Site.

4.3 Bombing Density and Incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB) and Country Boroughs (CB). The Site was located in Havant and Waterloo UD.

The figures for West Ham CB, generally considered to represent a high regional bombing density, are included for comparison.

Table 1 Bombing Statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1,000 acres)
Havant and Waterloo UD	**375**	**39**	**9**	**423**	**35.0**
Portsmouth CB	1,221	34	7	1262	136.8
Chichester RD	1,154	38	29	1,221	11.9
Droxford RD	599	38	26	663	10.6
Petersfield RD	457	9	19	485	8.6
West Ham CB	1,498	45	47	1,590	334.0

Note that Table 1 excludes the figures for AA shells. Discrepancies between this list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

The nearest recorded incidents to the Site are described below.

6th December 1940

At least 12No. HE bombs and 200No. Incendiary Bombs (IBs) fell on unspecified locations in Havant, Bedhampton and on Hayling Island.

15th January 1941

1No. Delayed Action Bomb (DAB) exploded in Langstone Harbour, approximately 0.5km southwest of the Site.

10th March 1941

4No. HE bombs fell near Langstone Bridge, approximately 0.8km southeast of the Site.

11th March 1941

1No. HE bomb fell in the Searchlight Field, approximately 0.7km northeast of the Site.

9th April 1941

HE bombs and IBs fell in unspecified locations across South Hampshire, including Havant.

11th April 1941

8No. HE bombs fell between Farlington and Langstone Bridge, approximately 0.5km south of the Site.

5th June 1941

1No. HE bomb fell on the northern end of Langstone Harbour, southwest of Bedhampton, approximately 0.7km west of the Site.

9th June 1941

2No. HE bombs fell on Langstone Harbour, near the Binness Islands, approximately 1km southwest of the Site.

21st August 1942

4No. HE bombs fell on Ranelagh Road, approximately 0.6km north of the Site.

16th August 1943

An estimated 40No. HE bombs fell Langstone Harbour, within approximately 5km of the Site.

1No. Oil Bomb (OB) and an unspecified number of IBs fell on fields to the rear of Havant waterworks, approximately 0.5km north-northeast of the Site.

2No. HE bombs and an unspecified number of IBs fell on open ground south of the railway line, approximately 0.7km west of the Site.

3No. HE bombs fell near Farlington Marshes, approximately 1km southwest of the Site.

1No. HE bomb crater was recorded on Long Island, approximately 1km southwest of the Site.

IBs fell on Farlington Marshes, south of the railway line, approximately 1km west of the Site.

26th April 1944

1No. HE bomb fell to the rear of Homewell, approximately 1km northeast of the Site.

15th May 1944

At least 22No. HE bombs fell in Langstone Harbour, within approximately 5km of the Site.

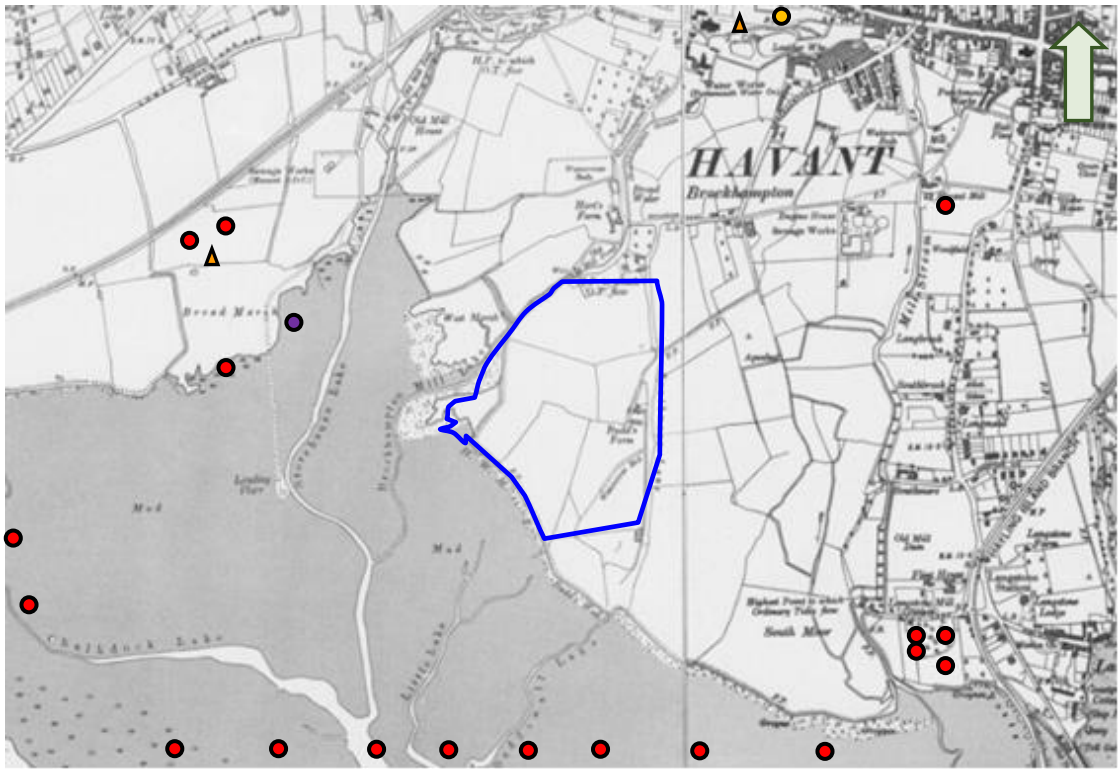
It should be noted that during WWII, many UXB were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXB were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Figure 5 is a map showing the approximate locations of bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area. The map has been compiled from a number of different sources, including air raid incident reports, bomb census maps and historical aerial photographs.

Note that air raid incident reports did not always record precise locations, often only indicating on which street, area or farm a bomb fell.

It should also be noted that the numbers and locations of bombs falling on the mudflats in Langstone Harbour were not always accurately recorded. The locations given for bomb impacts in this area are therefore indicative.

Figure 5	Compiled bomb impact map for the vicinity of the Site



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Legend	Site boundary	HE bomb	DAB	IBs	OB

Plate 5 is an aerial photograph dated the 19th April 1946. No significant residual bomb damage has been identified on the Site.

Some possible bomb damage has been identified to the northeast of the Site.

Plate 5	Aerial photograph, 19th April 1946



Source: Historic England *Not to scale*

Legend	Site boundary	Possible bomb damage

No records have been found indicating that bombs fell on the Site and no significant bomb damage or cratering has been identified on the Site on WWII aerial photographs.

The recorded bombing density in the immediate vicinity of the Site was low. The majority of air raids in the Havant region were concentrated towards the west and southwest of Hayling Island and the bombing decoys located around Langstone Harbour, between approximately 1km and 5km south and southwest of the Site. More than 200No. bombs are recorded falling on these areas, with far fewer bombs falling on the mainland.

[redacted] is not considered to provide a source of UXO hazard to the Site.

4.4 Geology and Bomb Penetration Depths

It is important to consider the geological materials present on the Site at the time that a bomb was dropped in order to establish its maximum penetration depth. British Geological Survey (BGS) 1:50,000 Sheet 316, Fareham (Solid and Drift) and BGS borehole records were consulted.

During WWII the geology of the eastern part of the Site comprised River Terrace Deposits overlying the Lewes Nodular Chalk Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the eastern part of the Site assuming WWII ground conditions of approximately 2m of stiff clay over 5m of gravel overlying more than 10m of chalk.

Table 2	Estimated average maximum bomb penetration depths (River Terrace Deposits)	
Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.5m
	500kg	7.0m
	1,000kg	9.5m

During WWII the geology of the western part of Site comprised Alluvium overlying the Lewes Nodular Chalk Formation.

Table 3 provides an estimate of average maximum bomb penetration depths for the western part of the Site assuming WWII ground conditions of approximately 2m of soft clay over 5m of gravel overlying more than 10m of chalk.

Table 3	Estimated average maximum bomb penetration depths (Alluvium)	
Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.0m
	500kg	7.5m
	1,000kg	10.0m

The estimated bomb penetration depths given in Tables 2 and 3 are from the WWII ground level and are based on the following assumptions:

a) High level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 degrees to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

A high altitude release of a bomb will result in ground entry at between 10^{o} and 15^{o} to the vertical with the bomb travelling on this trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked lateral movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

In low level attacks over deep water bodies, the offset distances from the point of entry at the water surface may be considerably enhanced due to hydrodynamic effects before the bomb penetrates or settles on the sea bed. Shallow water has little effect on bomb penetration depths during high level attacks.

5 WWII DEFENCES

5.1 Bombing Decoys

In order to draw enemy aircraft away from towns and other strategically important targets, a series of decoys were developed between 1940 and 1941.

They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. Approximately 792No. static decoy sites were built at 593No. locations in England. In addition, numerous temporary and mobile decoys were deployed.

Several different types of decoy were devised:

- Night time dummy airfields (Q sites).
- Daytime dummy airfields (K sites).
- Diversionary fires to simulate successful bombing raids on airfields (QF sites), petroleum depots (P sites) and major towns and cities (Starfish or SF sites).
- Simulated urban lighting (QL sites).
- Dummy Heavy Anti-Aircraft (HAA) batteries, factories and buildings (C series).
- Mobile decoys representing 'hards' for troop embarkation (MQLs), tanks and other vehicles.

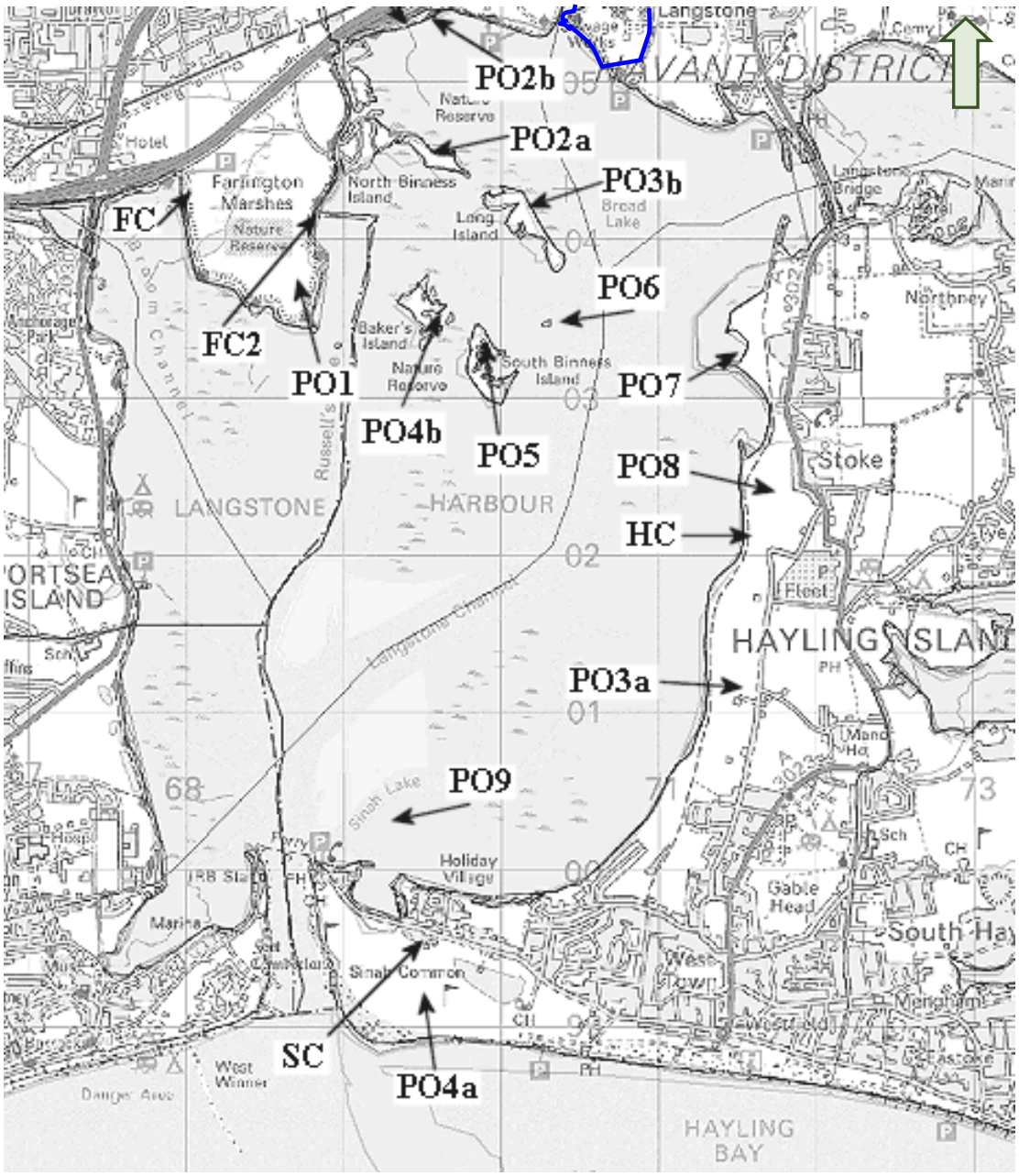
Machine gun emplacements and Light Anti-Aircraft (LAA) guns were used to prevent possible enemy landings at decoy airfields.

By their nature, decoy sites provide a potential risk from Unexploded Bombs (UXB), both within the decoy site boundary and in the surrounding areas.

Several bombing decoys were established in Langstone Harbour in order to divert bombing away from the strategically important military establishments in Portsmouth.

Figure 6 is a plan of the bombing decoys around Langstone Harbour during WWII.

Figure 6	Plan of bombing decoys around Langstone Harbour, WWII



Source: Portsdown Tunnels *Not to scale*

Legend	Site boundary

The nearest recorded bombing decoy was PO3b located at Long Island (SU 702042), approximately 1km southwest of the Site.

The decoys situated around Langstone Harbour and Hayling Island succeeded in attracting bombing away from the military targets in Portsmouth on several occasions and accounted for much of the bombing in the vicinity of the Site. Bombing was concentrated on the southwest and west of Hayling Island and the centre of Langstone Harbour, more than 5km from the Site.

No records have been found indicating that the decoys at North Binness and Long Island, those nearest to the Site, were heavily bombed.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

5.2 Anti-Aircraft Defences

Anti-Aircraft (AA) gun batteries were targeted by the Luftwaffe. They were also a source of Unexploded AA (UXAA) shells which could land up to 27km from the firing point during WWII, although more typically fell within 15km. These could be distributed over a wide area.

AA batteries present a potential source of UXO hazard as a result of the storage, use and disposal of ordnance associated with the armaments used. They may have a risk from small caches of ammunition buried locally to them. 3No. types of AA batteries existed:

- Heavy Anti-Aircraft (HAA) batteries of large guns designed to engage high flying bomber aircraft. These tended to be relatively permanent gun emplacements.
- Light Anti-Aircraft (LAA) weaponry, designed to counter low flying aircraft. These were often mobile and were moved periodically to new locations around strategic targets such as airfields.
- Rocket batteries (ZAA) firing 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km were also relatively permanent emplacements.

Many AA batteries were associated with searchlights and consequently 'visible' at night, providing clear targets to the Luftwaffe bombers and a potential for UXB.

During WWII the Site was within the range of guns deployed in the Portsmouth and Chichester Gun Defended Areas (GDAs).

Table 4 is a list of recorded HAA gun batteries and ZAA rocket batteries within 10km of the Site.

Table 4 WWII HAA and ZAA batteries within 10km of the Site

Grid Reference	Serial No.	Location	Armament	Approximate Distance and Direction from Site
SU 722037	P5/-	Hayling	4 x 5.25" guns	2.0km SE
SU 686070	P11/-	Moorlands	4 x 3.7" guns	2.5km NW
SU 728091	P20/-	Prospect Farm	Unknown	4.1km NE
SU 673022	P24/-	Highgrove	4 x 3.7" guns	4.5km SW
SZ 701997	P2/-	Sinah	4 x 4.5" guns	5.3km S
SZ 699994	P2/-	Sinah	4 x 4.5" guns	5.8km S
SU 648035	A	North End	UP tubes	5.8km SW
SU 640075	P21/-	Southwich	4 x 3.7" guns	6.8km NW
SZ 745988	P43/-	Eastoke Farm	Unknown	7.3km SE
SU 793035	CH5/-	Childham	4 x 3.7" guns	8.5km E
SZ 636989	P1/-	Southsea Common	4 x 4.5" guns	9.2km SW
SZ 636987	B	Southsea Common	UP tubes	9.4km SW
SZ 781978	CH9/-	West Wittering	Unknown	10.0km SE

It should be noted that the lack of official records of HAA batteries or armaments cannot be taken to imply their absence because many units were mobile and were moved around as operational requirements dictated.

Given the number of gun batteries in the surrounding area, the potential for a UXAA shell to have fallen unnoticed on the Site, whilst unlikely, cannot be totally discounted.

5.3 Barrage Balloons and Anti-Landing Obstacles

Balloon barrages were flown in many British towns and cities to protect against air raids. Their presence deterred low flying aircraft, making it more difficult for bombs to reach their intended targets. Barrage balloon sites can be a source of UXO as they were targeted by the Luftwaffe. They also often had a small explosive charge fitted with tilt fuzes attached approximately 50m from each end of the balloon cables and designed to detonate if the cables were hit by an aircraft.

Measures were also taken to prevent enemy aircraft landing in the event of invasion. Obstructions were constructed around airfields and on other open sites deemed fit for use as landing grounds. Solid obstructions (such as concrete blocks), posts or stakes, felled trees, haystacks, scaffolding with wire and trenching were the main measures used.

No records have been found indicating that barrage balloons or anti-landing obstacles were located on or in close proximity to the Site.

5.4 Anti-Invasion Defences

Defence structures are a potential source of UXB as they were especially targeted by low flying enemy aircraft, particularly during 'tip and run' raids which were common in industrialised regions. These defences may also be associated with small caches of UXO in the form of small arms, used by the troops manning the emplacement.

The rapid advance of German Troops into France, Holland and Belgium after the start of WWII prompted the War Office to review the vulnerability of the UK to invasion and a decision was taken to begin work on a national plan of anti-invasion defences. Static defences were built to interrupt and delay the progress of any invading force.

Coastal defences were strengthened (the 'Coastal Crust'). These defences included barbed wire entanglements and minefields, which were often combined to give defence in depth.

Inland, lines of defence structures were constructed along 'Stop Lines' in order to impede enemy progress for long enough to allow mobile defending forces to counter-attack.

Stop Lines included the fortification of key 'centres of resistance', such as river crossings and important road or rail junctions that could seriously hamper the enemy's advance across country. Bridges were mined for demolition and tank traps installed.

Stop Lines were further integrated into a network of fortified nodal points and 'Anti-Tank (AT) Islands'.

No records of anti-invasion defences on or in close proximity to the Site have been found.

5.5 Pillboxes, Mortar and Gun Emplacements

Defences also included spigot mortar positions and gun emplacements.

Spigot mortars, also known as Blacker Bombards, were used primarily in an anti-tank role at road blocks or to defend airfields. Typically they fired a 20 pound (lb) HE mortar bomb. The fixed positions, in weapons pits with ammunition lockers, were frequently positioned near pillboxes.

Spigot mortar positions could be either fixed or mobile.

No records of gun emplacements on or in close proximity to the Site have been found.

Pillboxes provide a potential UXO hazard both from the storage, use and disposal of ordnance associated with them and from UXB because they were targeted by enemy aircraft.

Pillboxes were common along Stop Lines, perimeters of airfields, potential land invasion sites and around important civil sites. Several different designs existed including Seagull Trenches (semi-buried structures), Alan Williams and Tett Turrets (small prefabricated pillboxes). Fortified sites, buildings or loop-holed walls also functioned as pillboxes.

No records of pillboxes on or in close proximity to the Site have been found.

5.6 Home Guard and Auxiliary Units

Local Defence Volunteers (LDV) units, later known as the Home Guard, were located in all cities, towns and large villages. Anti-invasion defences were to be defended by the Home Guard and regular Army troops for as long as possible in the event of an invasion. The troops were issued with 'No Withdrawal' orders.

Important elements of the ordnance supply for the use of the Home Guard included substantial supplies of Mills bombs (fragmentation grenades) and Self Igniting Phosphorus (SIP) grenades as well as machine gun and small arms ammunition.

Records of Home Guard activities and related sites are rarely preserved. Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were either buried or dumped in lakes and ponds. Given the irregular nature of this activity, the possibility of items of UXO being discovered at any locations occupied or used for training by the Home Guard can never be totally discounted.

In addition to the regular Home Guard, Auxiliary Units existed which were made up of guerrilla troops trained in sabotage and assassination in case of invasion. Sites used by these Units were Top Secret and many locations are still unknown.

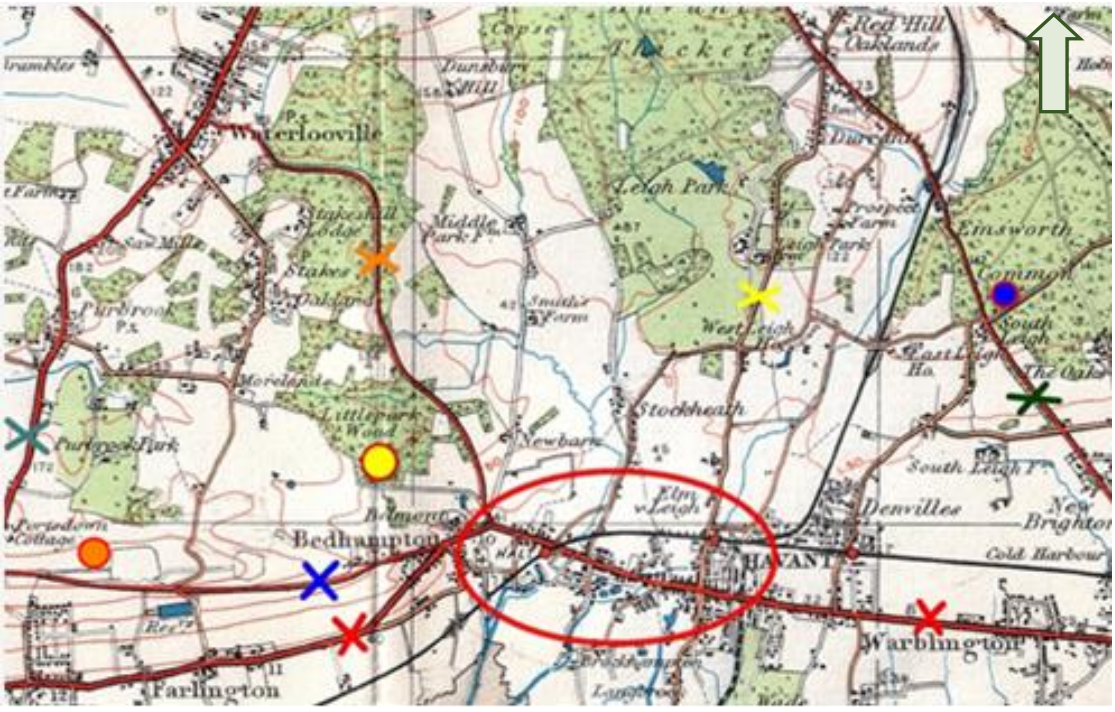
No Home Guard activity has been identified on or in close proximity to the Site.

The 16th (Havant) battalion of the Home Guard was active in the region patrolling local transport infrastructure, industrial works and docklands.

2No. Auxiliary Units were active in Havant. Havant (West) Patrol had an Operational Base situated in Littlepark Wood (SU 694072), approximately 1.9km northwest of the Site. The group patrolled the railways and Havant's major roads.

Figure 7 is a map denoting Havant (West) Patrol's Operational Base (yellow circle) and targets (crosses), which largely comprised strategic road and railway crossings. The Patrol had a training ground on Emsworth Common (blue circle) and undertook night training exercises near Purbrook Park (orange circle).

Figure 7	Map showing Havant (West) Auxiliary Unit Patrol Targets



Source: Coleshill House *Not to scale*

Home Guard and Auxiliary Unit activity is not considered to provide a source of UXO hazard to the Site.

5.7 Minefields and Mined Locations

Minefields were laid along the coast, in estuaries and along the banks of major rivers to deter infantry invasion. Strategic points such as bridges and gaps in cliffs were mined to impede enemy advance. Most of the mined locations in the UK have been cleared and the risk of finding UXO in these areas is considered to be low.

No records of minefields on or in close proximity to the Site have been found.

6 MILITARY AIRFIELDS

Military airfields offer the potential for significant UXO hazards due to the use, storage and disposal of ordnance and as a result of enemy bombing during WWI and WWII.

Airfields active during WWII were targeted by the Luftwaffe, providing a potential source of UXB on the airfield.

As bombing accuracy was so poor during WWII, it is likely to find UXB in the surrounding areas. Aircraft crashes are also associated with operational airfields.

No records of any military airfields on or in close proximity to the Site have been found.

During WWI the nearest operational military airfield was Royal Flying Corps (RFC) Gosport (SU 586010), located approximately 12.3km southwest of the Site. The airfield was used by the RFC and the Navy throughout WWI as a training school before being handed to the newly formed RAF in 1919.

During WWII the nearest operational military airfield was RAF Thorney Island (SU 761025), located approximately 5.6km southeast of the Site. Opened in 1938, the airfield was predominantly used by Coastal Command, and a number of different squadrons were stationed there. Post-WWII the airfield remained operational, and in 1955 was used by Search and Rescue (SAR) squadrons until their relocation to Lossiemouth in 1973. The airfield is currently controlled by the Royal Artillery.

Military airfields are not considered to provide a source of UXO hazard to the Site.

6.1 Aircraft Crashes

Aircraft crash sites are a known UXO hazard. The MoD advises that if crashed aircraft are found, the safest policy is to leave them alone where possible. Unless disturbed there is no statutory requirement for the MoD to clear such sites.

No records of any military aircraft crashes on or in close proximity to the Site have been found. The nearest are described below.

11th June 1944

1No. Supermarine Spitfire IX fighter aircraft (MJ499) crashed into Langstone Harbour, approximately 3.4km southwest of the Site.

1No. Bristol Blenheim light bomber aircraft crashed in North Hayling, approximately 3.4km southeast of the Site.

Aircraft crashes are not considered to provide a source of UXO hazard to the Site.

7 EXPLOSIVES AND MUNITIONS ESTABLISHMENTS AND DEPOTS

Explosives and munitions manufacturing or storage sites offer a particularly high risk from both explosive substances and UXO. Standard procedures of explosive/ordnance disposal through burial or burning means that explosive and UXO hazards will be present in some areas of such establishments.

In addition, UXB hazards may be present as a result of enemy bombing during WWI and WWII.

7.1 Explosives and Ordnance Factories

No records of any explosives or ordnance factories on or in close proximity to the Site have been found.

7.2 Munitions Stores

Local ammunition caches would have been present near to defended road blocks, pillboxes, HAA and LAA sites. Most of those associated with the anti-invasion sites are understood to have been cleared.

No records of any official munitions depots on or in close proximity to the Site have been found.

During WWI, Farlington Race Course, approximately 2.9km east of the Site, was used as an ammunition dump.

Munitions stores are not considered to provide a source of UXO hazard to the Site.

7.3 Informal Munitions Depots

Informal munitions depots, often made by requisitioning roadside lay-bys or parks. Other informal munitions depots were commonly located in areas of woodland or on train wagons along sidings in marshalling yards.

No records of any informal munitions depots on or in close proximity to the Site have been found.

The Havant (West) Auxiliary Patrol Unit had an explosives store in their Operational Base in Littlepark Wood (SU 694072), approximately 1.9km northwest of the Site

Informal munitions depots are not considered to provide a source of UXO hazard to the Site.

7.4 Munitions Disposal Areas and Bomb Cemeteries

Munitions disposal areas were often made by requisitioning open areas of land, usually away from habitation. Marshland, beaches or sand dunes were frequently used for this purpose. Disposal of munitions was carried out in many different ways, ranging from destruction to burial. Full records were not necessarily maintained for these locations, and so they can potentially be a source of UXO.

No records of any official munitions disposal areas on or in close proximity to the Site have been found.

Farlington Marshes, approximately 3km west of the Site, were used for bomb disposal operations during WWII.

Munitions disposal areas are not considered to provide a source of UXO hazard to the Site.

8 FIRING RANGES AND MILITARY TRAINING AREAS

By their nature, firing ranges and military training areas represent a potential source of UXO due to associated training activities. The training will involve both practice and live munitions and will offer a significant risk from a very wide range of potential UXO.

8.1 Small Arms Ranges

Small arms ranges (such as rifle ranges) and close combat ranges (such as mortar and grenade ranges) are likely to provide a significant source of UXO. It should be noted that even on small arms ranges, larger munitions such as mortars or grenades cannot be discounted.

No records of any small arms ranges on or in close proximity to the Site have been found.

The Home Guard had a miniature rifle range in Connaught Drill Hall, located on Park Road South, approximately 0.9km northeast of the Site.

Small arms ranges are not considered to provide a source of UXO hazard to the Site.

8.2 Artillery Ranges

Artillery ranges will have utilised a wide range of munitions, predominantly shells, although close combat munitions such as mortars, or larger munitions such as bombs, cannot be discounted.

No records of any artillery ranges on or in close proximity to the Site have been found.

8.3 Bombing Ranges

Bombing ranges will have primarily used bombs, although other munitions such as shells and close combat munitions such as mortars cannot be totally discounted.

No records of any bombing ranges on or in close proximity to the Site have been found.

8.4 Training Areas

Training areas will have primarily used blank ammunition or practice shells in 'dry' areas, although live munitions such as shells and close combat munitions such as mortars cannot be discounted in any training area.

No records of any military training areas on or in close proximity to the Site have been found.

A small special assault unit, Detachment No. 385 of the Royal Marines, used Helmsley Camp, approximately 3.2km northeast of the Site, for training in field craft and map reading, as well as training in both armed and unarmed combat.

Southleigh Forest, approximately 4.5km northeast of the Site, was used for tank training in preparation for the D-Day landings.

Training areas are not considered to provide a source of UXO hazard to the Site.

9 EXPLOSIVE ORDNANCE CLEARANCE ACTIVITIES

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (representing 11%) were recorded as UXBs. However, records from the Royal Engineers who were responsible for bomb disposal at the time indicate that as of 27th February 1946 upwards of 45,000No. UXBs were disposed of.

On average 8.5% UXBs later self-exploded. In some cases the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear.

Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office statistics also show that between October 1940 and May 1941 most of the UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and the size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

9.1 Abandoned Bombs

No records of any officially abandoned bombs on the Site have been found.

9.2 EOC Tasks

Zetica Ltd holds no records of post-WWII EOC tasks being undertaken in the vicinity of the Site.

The MOD has provided no additional information on official EOC tasks on the Site.

10 UXO HAZARD ASSESSMENT

10.1 UXO Hazard Level

The definitions for the levels of UXO hazard are provided below.

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present and that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 8.

Figure 8 UXO hazard zone plan of the Site



Source: Google Earth *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

11 UXO RISK ASSESSMENT

11.1 UXO Risk Level

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard.

Firstly, the probability of encountering UXO (PE) has been considered and rated for the different construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating a UXO (PD) has been considered and rated for the different construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
20 to 25	Frequent, highly likely, almost certain.	5
13 to 19	Probable, more likely to happen than not.	4
6 to 12	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0

P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.

The likelihood of encountering and detonating UXO during site works is multiplied by the severity of such an event occurring (P x S), in order to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix

		SEVERITY (S)					
		5	4	3	2	1	0
LIKELIHOOD (P)	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

The final risk assessment for the Site is given in Table 5.

Table 5 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Shallow Excavations	1	1	1	1	5	5	Low
	Deep Excavations	1	1	1	1	5	5	Low
	Piling/boreholes	1	1	1	1	4	4	Low
Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
	Deep Excavations	1	1	1	1	4	4	Low
	Piling/boreholes	1	1	1	1	3	3	Low

PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)

Shallow excavations defined as <1.0m below ground level (bgl).

UXO Risk	Matrix Rating	Definition
Very Low	0-1	Little action is required by the client provided that suitable records and procedures are in place to ensure appropriate action is undertaken should the UXO risk level change.
Low	2-5	Tolerable to the client as engineering activity need not alter if UXO related procedures and controls are strictly adhered to.
Moderate	6-15	May be tolerable for the client, but it is prudent to reduce the risk where cost effective and reasonably practicable.
High	16-20	Tolerable to the client only where further risk reduction is impracticable or disproportionate to the risk involved. Essential that all practicable measures are taken to reduce the level of risk.
Very High	21-25	Unacceptable to the client except in extraordinary circumstances. Imperative that all control measures are taken.

11.2 Risk Mitigation Recommendations

To ensure that the UXO risk is reduced to As Low As Reasonably Practicable (ALARP) the following mitigation is advised:

Where a low risk of UXO encounter is anticipated, industry good practice is simply to raise the awareness of those involved in excavations so that in the unlikely event that a suspect item is discovered, appropriate action is taken. This can be achieved through UXO awareness briefings to site staff.

Clearance certification for borehole or pile locations is considered prudent only if a zero tolerance to risk is adopted. Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.

Table 6 below gives recommended actions in relation to the potential UXO risk level and the anticipated Site activity.

Further advice on the mitigation methods can be provided by Zetica on request.

Table 6	Risk mitigation for assumed Site activities			
Risk Level	**Typical Future Activity on the Site**			
	None	**Shallow Excavations (<1.0m)**	**Deep Excavations (>1.0m)**	**Boreholes or Pile Construction**
Very low	Ensure suitable records and procedures are in place to highlight the risk should future development be planned.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.
Low	**As very low.**	**As very low.** **+ It is considered prudent to include some UXO awareness training in site inductions.**	**As very low.** **+ It is considered prudent to include some UXO awareness training in site inductions.**	**As very low.** **+Clearance certification for borehole or pile locations would be considered prudent only if a zero tolerance to risk is adopted.** **Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.**
Moderate	As very low.	As low. +Non-intrusive investigation methods considered prudent where practical. +Alternatively, EOC Engineer supervision is considered prudent.	As low. +Non-intrusive investigation methods considered prudent where practical. +Alternatively, EOC Engineer supervision is considered prudent.	As low. +Clearance certification for borehole or pile locations is considered essential.
High	As very low.	As moderate. +Non-intrusive investigation methods considered essential where practical. + Alternatively, EOC Engineer supervision is considered essential.	As moderate. +Non-intrusive investigation methods considered essential where practical. + Alternatively, EOC Engineer supervision is considered essential.	As moderate.
Very High	Requires immediate or special attention.	Requires immediate or special attention.	Requires immediate or special attention.	Requires immediate or special attention.
The above table is for guidance only.				

Appendices

Appendix 1 UXO Hazard and Ordnance Types

When assessing the risk from UXO including UXB, it is important to be aware of ordnance type and function. The following Section briefly describes the more common types of UXO. More data on these can be found at http://[redacted]downloads-and-resources/ordnance-data-sheets/.

A1.1 Small Arms Ammunition

Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Larger calibre small arms munitions can contain fuze mechanisms and high explosives or pyrotechnic fillings and may have been used for anti-aircraft or anti-vehicle purposes.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance. SAA is often associated with discarded ammunition boxes around firing practice ranges. The Plate below illustrates some common SAA.

Plate	Photograph of typical WWII small arms ammunition



Source: Google Images

A1.2 Hand Grenades

Hand grenades can be filled with explosives or chemicals and have 3No. main parts, a body, a fuze with a pull ring and a safety-clip assembly. Fragmentation grenades are the most common and have a metal or plastic body filled with an explosive. Most use a burning delay fuze that functions for 3 to 5 seconds after the safety lever is released.

Some, such as smoke grenades, are activated instantly when the lever is released. The Plate below illustrates the typical character and condition of No. 36 hand grenades (Mills Bombs) that have been excavated from a site.

Plate	Photographs of a typical and an excavated WWII No. 36 hand grenades



Source: Google Images





Source: Zetica Ltd

A1.3 Projected Grenades

Projected grenades are among the most commonly found UXO items, particularly the 40mm type. These contain high explosives and use a variety of fuzes, including some of the most sensitive internal impact-fuzing systems. They are extremely dangerous and can explode if moved or handled.

A1.4 Mortars

A mortar is a short tube designed to fire a projectile at a steep angle. Mortars can range from approximately 50mm to 280mm in diameter and can be filled with explosives, toxic chemicals, white phosphorous or illumination flares. They generally have a thinner metal casing than projectiles, but use the same types of fuzing and stabilisation.

During WWII there are records that the target areas of RAF practice bombing ranges were occasionally used for mortar training.

The Plate below shows a typical 2-inch mortar bomb found (left) and a demonstration 3-inch mortar bomb (right).

Plate	Photographs of WWII 2-inch and 3-inch mortars



Source: Daily Mail



Source: Zetica Ltd

A1.5 Shells

Shells are a projectile containing an explosive charge designed to burst the casing that can contain High Explosives, pyrotechnic compounds or other chemicals.

Shells can be found in a range of sizes, from <20mm to several times this size. The most likely shells to be found on the Site are Small Arms Ammunition (SAA) or UXAA shells that have fallen back to the ground unexploded.

Most commonly used anti-aircraft shells were 2" and 3.7" HE shells.

If fired and found as UXO, shells can offer a particular hazard from accidental detonation as they can have sensitive fuze mechanisms. A fuze is a device which incorporates mechanical, electrical, chemical or hydrostatic components to initiate a train of fire or detonation.

The Plate below is a photograph of a 3.7" UXAA shell found in Camberwell, London.

Plate	Photograph of a recently excavated 3.7" AA shell



Source: Zetica Ltd

A1.6 Incendiary Bombs

Incendiary Bombs (IBs) ranged from small 1kg thermite filled, magnesium bodied bombs to a 250kg 'Oil Bomb' (OB) and a 500kg 'C300' IB. By far the most common air dropped devices across the UK during WWII were small 1kg to 2kg IBs.

In some cases the IBs were fitted with a very small High Explosive (HE) bursting charge. This exploded after the bomb had been alight for a few minutes causing burning debris to be scattered over a greater area. The C300 bombs were similar in appearance to 500kg HE bombs.

The small amount of HE, if any, and the almost negligible potential for IBs to remain active after more than 65 years in the ground means that these items have very little prospect of causing damage. In the majority of cases if IBs are found in the ground, the incendiary materials have deteriorated to such an extent that they are considered to provide a low UXO hazard level.

However, since magnesium and phosphorus were common components in IBs, some localised chemical contamination may occur where the contents have leached out of the IB into the surrounding soil.

The Plate below shows a typical variety of fragmentary remains of IBs and 2No. IBs recovered by the Civil Defence during WWII.

Plate	Photographs of typical fragmentary remains of IBs and a UXIB



Source: Swansea Museum



Source: Museum of London

A1.7 German High Explosive Bombs

Probably the most common and certainly most publicised UXOs to be found in the UK are bombs. Air dropped bombs, as a result of WWII enemy action, are found on a relatively frequent basis as UXO. They tend to be highly publicised (at least on a local basis) due to the common disruption where an evacuation of the potentially affected area is put in place.

The amount of High Explosive and the potential for a fuze to still be activated means that these devices have the prospect of causing some of the most widespread damage. WWII bombs were particularly sophisticated for their time, with anti-tamper fuzes.

Many German bombs were designed to not explode on impact and instead to cause disruption as a UXB. Some fuzes were set with a delay time of over 70 hours. During this time, an anti-tamper fuze could also be activated to detonate should it be disturbed.

The most commonly used bombs during WWII were the 50kg and 250kg sized general purpose bombs. Less frequently, the 500kg bomb was also used. Larger bombs were used, but so infrequently that any assessment of hazard is more typically based on bombs ranging up to 500kg only.

It should be noted that the June 2008 find of a 1000kg bomb in London, does demonstrate that larger bombs can be found and any risk mitigation measures should consider this.

The Plate below shows the variety of UXB recovered by the Civil Defence during WWII.

Plate	Photograph of a variety of UXB recovered by the Civil Defence during WWII



Source: Imperial War Museum

A1.8 Detonators, Gaines and Fuzes

Bomb components such as detonators, gaines and fuzes were stored at operational airfields during WWII and typically contained some type of explosive charge to initiate the detonation of a munition.

A wide variety of these components were used and examples of some common fuzes are shown in the Plate below.

Plate	Photographs showing examples of WWII fuzes



Source: Zetica Ltd

A1.9 Land Mines

Wartime activities provide numerous sources of UXO within the land environment. Whilst efforts have been made to clear the known British minefields, it was common for mines to become lost for a variety of reasons and so not recovered. Additionally, such munitions might have been disposed of on an unofficial basis and so no records were kept.

Most of the mined beaches and other land areas in the UK have been cleared by the MoD. Occasionally, wave action or activities such as bombing caused mines to become displaced and these were missed as part of any past clearance activities.

The Plate below is a photograph of a typical WWII land mine used on the land area, beaches and cliffs around Britain. This example was found at Gatwick Airport formerly RAF Gatwick.

Plate	Photographs of original and recently excavated WWII land mines



Source: Google Images



Source: Zetica Ltd

A1.10 Home Guard Weapons

Initially, the Home Guard's armoury was largely second-hand and much of it was of WWI vintage. Personal weapons (such as shotguns) and home-made devices were also employed.

By the end of WWII, some units were well equipped with a wide variety of small arms and munitions.

These included .32, .38 and .455 revolvers, .303 P14, .300 P17 and .303 Canadian Ross rifles, anti-tank rifles and a variety of Sub- Machine Guns (SMG) such as the .45 Thompson and 9mm Sten Guns.

Other heavier Machine Guns (MG) at their disposal included Browning, Hotchkiss, Lewis, Vickers and Marlin MG. Sub-artillery weapons were developed for them, including grenade throwers (the Northover Projector) and spigot mortars (the Blacker Bombard). 2-pdr anti-tank guns and Projector, Infantry Anti Tank (PIAT) weapons were in circulation amongst some units, and the Home Guard also manned AA guns later in WWII.

Explosives were available to some Home Guard units and were used and stored by all Auxiliary Unit patrols. As well as the flame fougasse and hand grenades detailed in this Appendix, the Home Guard had stocks of Molotov Cocktails, Sticky Bombs and SIP grenades.

In October 2006 a cache of 76No. SIP grenades was found in a garden at Seend, Wiltshire. In October 2008, a further 26No. SIP grenades were discovered in a garden in Wimborne, Dorset. Similar caches were discovered in October 2009 in Hove, Sussex and during May 2010 in Halesowen in the West Midlands, and a further cache of 20No. was uncovered on a construction site at Birdlip, Gloucestershire, in July 2010.

Also in July 2010, a box of 24No. SIP grenades was found on Cogden Beach, Dorset. In April 2012, more than 8No. SIP grenades were found on a construction site in Banbury and destroyed by members of the Army Royal Logistic Corps (RLC).

In March 2015, 80No. SIP grenades were found at a building site in Eastbourne, some of which exploded before they could be made safe by a Bomb Disposal unit. In all 8No. cases, the bottles were in good condition and exploded in flames when broken.

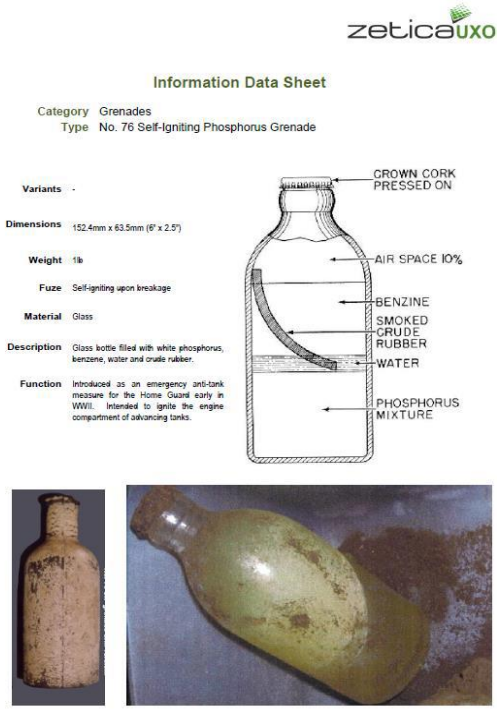
Most recently, in May 2016, 1No. No. 76 SIP grenade was found during excavation at Chapel Point, Lincolnshire forcing works to be delayed. During WWII, the site was occupied by a pillbox and gun emplacement associated with the heavily-defended 'Coastal Crust', manned by Home Guard units. The device was removed safely.

In January 2017, a cache of 24No. SIP grenades was discovered at Derriford, Plymouth and made safe by a Royal Navy Bomb Disposal Unit.

The Plate below is a photograph of a No. 76 SIP grenade (LHS) with an explanatory leaflet produced by ZeticaUXO for site staff (RHS).

Plate	Photograph of the No. 76 SIP grenade





Source: Zetica Ltd

Given the irregular nature of Home Guard activity, the possibility of items of UXO or weapons being discovered at any locations occupied or used for training by them can never be totally discounted.

A1.11 UXO Migration

It is possible for explosive material, UXO or ordnance scrap to migrate to a site during landfill or dredging operations or other ground works which import Made Ground or natural materials already containing UXO. It is important to understand the nature and age of such landfill or dredging operations when assessing the potential UXO hazard level on the site.

A1.12 Effects and Consequences

There have been a limited number of recorded incidents in the UK since WWII where bombs have detonated during engineering works, though a significant number of bombs have been discovered. Incidents involving smaller ordnance are, however, relatively common in the UK.

In the UK, there are no recorded incidents since the decade after WWII, of a UXB accidentally detonating. In recent years, bombs have been found that have fuze mechanisms that have started to operate indicating that given the right conditions a UXB may still function.

In June 2008 the UXB uncovered in the Lea Valley caused difficulty to No. 33 Regiment (Explosive Ordnance Disposal) Royal Engineers because the fuze mechanism started to operate.

The 1,000kg 'Hermann' bomb, the first of this size to be found in over 30 years, took 5 days to deactivate. This demonstrates that larger bombs can be found and any risk mitigation measures should provide the option to deal with this size of device. Since WWII, UXBs have been found on a regular basis in London.

Since WWII, UXBs have been found on a regular basis throughout Britain. Some of the most recent cases are described below.

In May 2009 1No. 50kg WWII bomb was found on a building site in Bexhill-on-Sea, Sussex, and on the 16th August 2009, 1No. 250kg WWII bomb was found near Ebberston, North Yorkshire. Both of these were destroyed in controlled explosions by Bomb Disposal Units.

On the 8th March 2010 1No. 500kg WWII bomb was found at Bowers Marsh in Essex by Zetica EOC operatives following a Zetica desk study concluding a high risk of UXB on the site. The bomb was demolished in situ by members of the Army Royal Logistics Corps (RLC).

The Plate below is a photograph of the bomb in situ.

Plate	Photograph of the 500kg WWII UXB at Bowers Marsh, 8th March 2010



Source: Zetica Ltd

On the 23rd February 2011, 1No. WWII UXB was found on a building site in Notte Street in Plymouth City centre. The bomb was removed by EOD personnel and demolished at sea.

On the 22nd July 2012, a landslip in the cliffs at Mappleton in the East Riding of Yorkshire exposed over 1,000No. UXO items, including practice bombs, mortars, rockets, shells and grenades. The cliff was part of a former bombing and artillery range, used during WWII and until the 1970s.

UXO items were removed by Explosive Ordnance Disposal (EOD) officers from Catterick and MoD staff from Leconfield. 15No. controlled explosions were undertaken by the Royal Engineers (RE) to detonate the more volatile items in situ, while other less hazardous UXO devices were left in place to be dealt with at a later date.

1No. WWI bomb (shown in the Plate below) was found on the Isle of Sheppey on the 2nd August 2012 during a geophysical survey following desk study research by Zetica Ltd which had established that a previously unknown [redacted] range existed on the site. A further WWI bomb was found in the same location in August 2015.

Plate	Photograph of WWI bomb, Isle of Sheppey, 2nd August 2012



Source: Zetica Ltd

On the 23rd March 2015, 1No. WWII 500kg UXB was found on a building site in The Grange, Bermondsey. The bomb was made safe by EOD personnel and removed for demolition.

On the 21st May 2015, 1No. 50kg UXB was found on a building site near Wembley Stadium, London Borough of Brent. The bomb was made safe by EOD personnel and removed for demolition.

On the 10th August 2015, 1No. 250kg UXB was found under the basement of a building site at Bethnal Green, London Borough of Tower Hamlets. It was made safe and removed by an EOD team from the RLC.

On the 21st September 2015, 1No. UXB was uncovered on a construction site in Cheylesmore, Coventry, by the operator of a mechanical digger. It was destroyed in situ by an EOD team from the RLC.

In January 2016, Zetica discovered 3No. 500lb British UXB at a former airfield in Cambridgeshire. These were destroyed in controlled explosions. The Plate below is a photograph of one of the bombs.

Plate	Photograph of a recently excavated WWII British 500lb GP bomb



Source: Zetica Ltd

On the 12th May 2016, 1No. 250kg UXB was found on a building site in Bath. It was made safe and then taken to a local quarry for demolition.

In September 2016 1No. 500kg UXB and 1No. torpedo were discovered during dredging works in Portsmouth Harbour. An additional 250kg HE bomb was discovered on the 16th November 2016. These devices were towed out to sea and destroyed in controlled explosions.

On the 19th January 2017, 1No. 50kg UXB was found during dredging works along the River Thames Victoria Embankment in Central London. The device was towed to Tilbury in Essex where it was destroyed in a controlled explosion.

There is a long list of incidents during construction work in Germany that in some cases have led to the deaths of workers.

In June 2010, 3No. members of a bomb disposal team were killed, and 6No. others injured, whilst attempting to defuze an unexploded WWII bomb in Goettingen, Central Germany.

The bomb, the second found in Goettingen in the space of a few days, was unearthed at a depth of 7.5m during excavations for a sports stadium.

In September 2008, 17No. people were injured and considerable damage occurred to adjacent buildings when a bomb exploded on a construction site in Hattingen, Germany.

In October 2006 during road works on a motorway near Aschaffenburg in Bavaria, southern Germany, a bomb was struck by a machine and detonated. The plant driver was killed and 5No. others injured, including passing motorists.

In a similar incident in October 2004 in Linz, Austria a bomb exploded injuring 3No. workers and causing considerable damage to plant. In the same month, a WWII bomb under a back garden in Vienna, Austria, was detonated without warning by a minor earth tremor, after remaining undiscovered for over 60 years.

Incidents involving UXO are also reported from the marine areas around the North Sea. For example, on 6th April 2005, 3No. Dutch fishermen were killed when they accidentally trawled up a WWII UX bomb which exploded when it hit the deck.

More recently, an unexploded HE bomb was trawled from the sea floor off South Shields on the 25th February 2015 but caused no damage.

Further details of similar finds can be found at http://[redacted]news/.

The effects of a partial or full detonation of ordnance are usually shock, blast, heat and shrapnel damage. A 50kg buried bomb can damage brick / concrete structures up to a distance of approximately 16m away. Unprotected personnel on the surface up to 70m away from the blast could also be seriously injured. Larger ordnance would obviously be more destructive.

Explosives rarely lose effectiveness with age, although over time mechanisms such as fuzes and gaines can become more sensitive and therefore more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay or similar materials.

The effects of a detonation of explosive ordnance are usually extremely fast, often catastrophic and invariably traumatic to any personnel involved.

Appendix 2 Abbreviations	
AA	Anti-Aircraft
ACPO	Association of Chief Police Officers
ALARP	As Low As Reasonably Practicable
ARP	Air Raid Precaution
ASACS	Air Surveillance and Control System
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
BDU	Bomb Disposal Unit
CBRN	Chemical, Biological, Radiological and Nuclear
CMD	Conventional Munitions Disposal
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FFE	Free From Explosives
HAA	Heavy Anti-Aircraft
HE	High Explosive
HSE	Health and Safety Executive
JSEODOC	Joint Services EOD Operations Centre
IB	Incendiary Bomb
IED	Improvised Explosive Device

IEDD	Improvised Explosive Device Disposal
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
PUCA	Pick Up and Carry Away
RAF	Royal Air Force
SIP	Self-Igniting Phosphorous
TEP	Time Expired Pyrotechnics
USAAF	United States Army Air Forces
UXB	Unexploded Bomb
UXO	Unexploded Ordnance

Appendix 3 Glossary & Definitions	
Abandoned Explosive Ordnance (AXO)	Abandoned Explosive Ordnance is explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Camouflet	The type of cavity produced when a charge explodes underground without breaking the surface of the earth to form a crater.
Demil	Derived from the term 'Demilitarisation', it refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame and a shock wave.
Device	This term is used for any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells or bombs.
Explosive	The term explosive refers to compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat and pressure. Obviously, these are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	Explosive Ordnance is all munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads, guided and ballistic missiles, artillery, mortar, rocket, small arms ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs & dispensers, cartridge & propellant actuated devices, electro-explosive devices, clandestine & improvised explosive devices, and all similar or related items or components explosive in nature.
Explosive Ordnance Clearance (EOC)	Explosive Ordnance Clearance is a term used to describe the operation of ordnance detection, investigation, identification and removal, with EOD being a separate operation.
Explosive Ordnance Disposal (EOD)	Explosive Ordnance Disposal is the detection, identification, on-site evaluation, rendering safe, recovery and final disposal of unexploded explosive ordnance.
Explosive Ordnance Reconnaissance (EOR)	Explosive Ordnance Reconnaissance is the detection, identification and on-site evaluation of unexploded explosive ordnance before Explosive Ordnance Disposal.

Explosive Remnants of War (ERW)	Explosive Remnants of War are Unexploded Ordnance (UXO) and Abandoned Explosive Ordnance (AXO), excluding landmines.
Explosive Substances and Articles (ESA)	Explosive substance are solid or liquid substance (or a mixture of substances), which is either: • capable by chemical reaction in itself of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. • designed to produce an effect by heat, light, sound, gas or smoke, or a combination of these as a result of a non-detonative, self-sustaining, exothermic reaction. Explosive article is an article containing one or more explosive substances.
Fuze	A fuze is the part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and in particular in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
High Explosive	Secondary explosives (commonly known as High Explosives (HE)) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are: Nitro glycerine (NG), Trinitrotoluene (TNT), AMATOL (Ammonia nitrate + TNT), Gunpowder (GP), and Cyclotrimethylenetrinitramine (RDX).
Munition	Munition is the complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions. This includes those munitions that have been suitably modified for use in training, ceremonial or non-operational purposes. These fall into three distinct categories:- • inert - contain no explosives whatsoever. • live - contain explosives and have not been fired. • blind - have fired but failed to function as intended.
Primary Explosive	Primary explosives are usually extremely sensitive to friction, heat, and pressure. These are used to initiate less sensitive explosives. Examples of primary explosives are: Lead Azide, Lead Styphnate, and Mercury Fulminate. Primary explosive are commonly found in detonators.

Propellants	Propellants provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are: Ballistite often found in a flake form and Cordite used in small arms ammunition.
Pyrotechnic	A pyrotechnic is an explosive article or substance designed to produce an effect by heat, light, sound, gas or smoke, or a combination of any of these, as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Unexploded Ordnance (UXO)	UXO is explosive ordnance that has been either primed, fuzed, armed or prepared for use and has been subsequently fired, dropped, launched, projected or placed in such a manner as to present a hazard to operations, persons or objects and remains unexploded either by malfunction or design.

Appendix 4 Bibliography

Birtles P, World War 2 Airfields, 1999

Bodleian Library, German Invasion Plans for the British Isles 1940, 2007

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S, & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance, a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Aerial Reconnaissance Photographs of England, Scotland and Wales, 2012

Cocroft W D, Dangerous Energy, 2000

Cocroft W D & Thomas R J, Cold War, 2003

Collier B, The Defence of the United Kingdom, 1957

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994.

Dobinson C S, Twentieth Century Fortifications in England, Volume I 1, Anti-Aircraft artillery, England's air defence gun sites. 1914 – 46. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 2, Anti-Aircraft artillery, site gazetteer, WWI. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I. 3. Anti-Aircraft artillery, 1914-46, Site gazetteer, WWII HAA & ZAA. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 4, Anti-Aircraft artillery, Site gazetteer, WWII LAA. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume I 5, Anti-Aircraft artillery, Sources. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume II, Anti-Invasion defences of WWII. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume III, Bombing decoys of WWII, England's passive air defence 1939-45. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Volume VIII, Civil defence in WWII, Protecting England's Civil Population. Council for British Archaeology, 1996

Dobinson C S, Twentieth Century Fortifications in England, Supporting paper AA/1 Searchlight sites in WWII. Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Evans M, Forrest H, Haynes D, Young R, Draper R, Sarangi J & Murray V, Discovery of WWII Special Incendiary Phosphorous (SIP) Grenades in a Wiltshire garden, Chemical Hazards and Poisons Report, 2007

Fegan T, The Baby Killers, 2002

Forty G, British Army Handbook 1939-1945, 2006

Front Line 1940-41, The Official Story of the Civil Defence of Britain, 1942

Groves C, The Home Guard of Britain, 1943

Innes G B, British Airfields of the Second World War, 1995

Nesbit R C, The Battle of Britain, 2000

Osborne M, Defending Britain, Twentieth-Century military structures in the landscape, 2004

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rawson A, British Army Handbook 1914-1918, 2006

Smith D J, Britain's Military Airfields 1939-45, 1989

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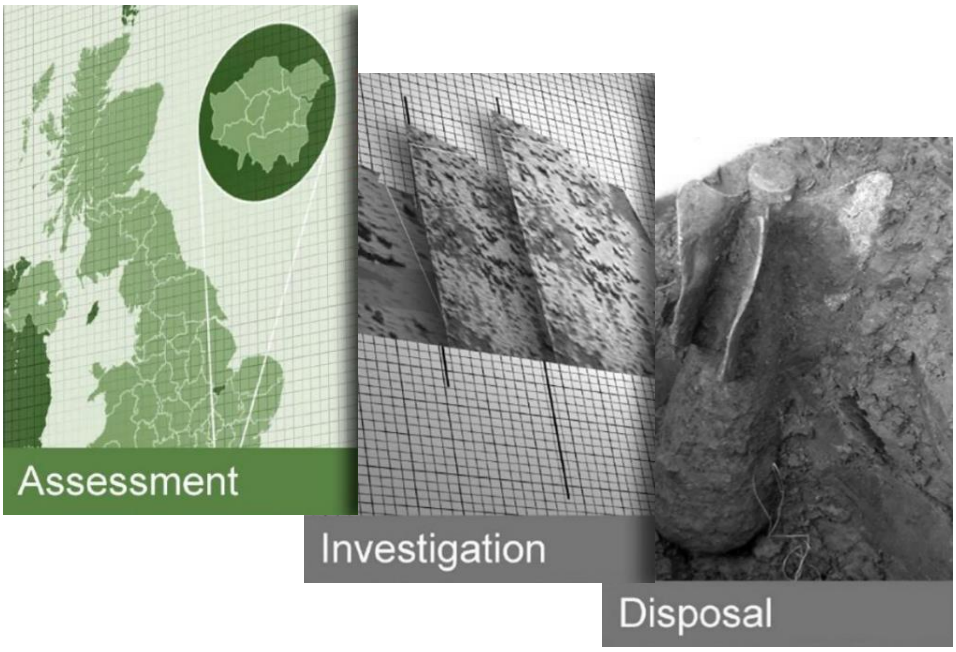
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- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Topographic surveys
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]


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UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R12**
Revision	**A**
Project Title	**WRP to Bedhampton Springs**
Client	**Southern Water**
Date	**26th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 5 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R12-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) or World War Two (WWII) have been found.
- During WWII the main strategic targets in the vicinity of the Site included aircraft manufacturing, military camps and barracks, major transport infrastructure, and Brockhampton Water Works.

- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 0.2km east of the Site, on the 21st August 1942.
- There were 14No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R12-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FAA	Fleet Air Arm
HAA	Heavy Anti-Aircraft
HE	High Explosive
HER	Historic Environment Record
IB	Incendiary Bomb
IWM	Imperial War Museum
KBB	Kite Balloon Base
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
QL	Quick Light
RA	Royal Artillery
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RE	Royal Engineers
ROC	Royal Observer Corps
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WRNS	Women's Royal Naval Service
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec, on behalf of Southern Water, to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a pipeline route totalling approximately 0.7km off Mill Lane and the A27, in Bedhampton, Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Havant Borough Council, Hampshire Record Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

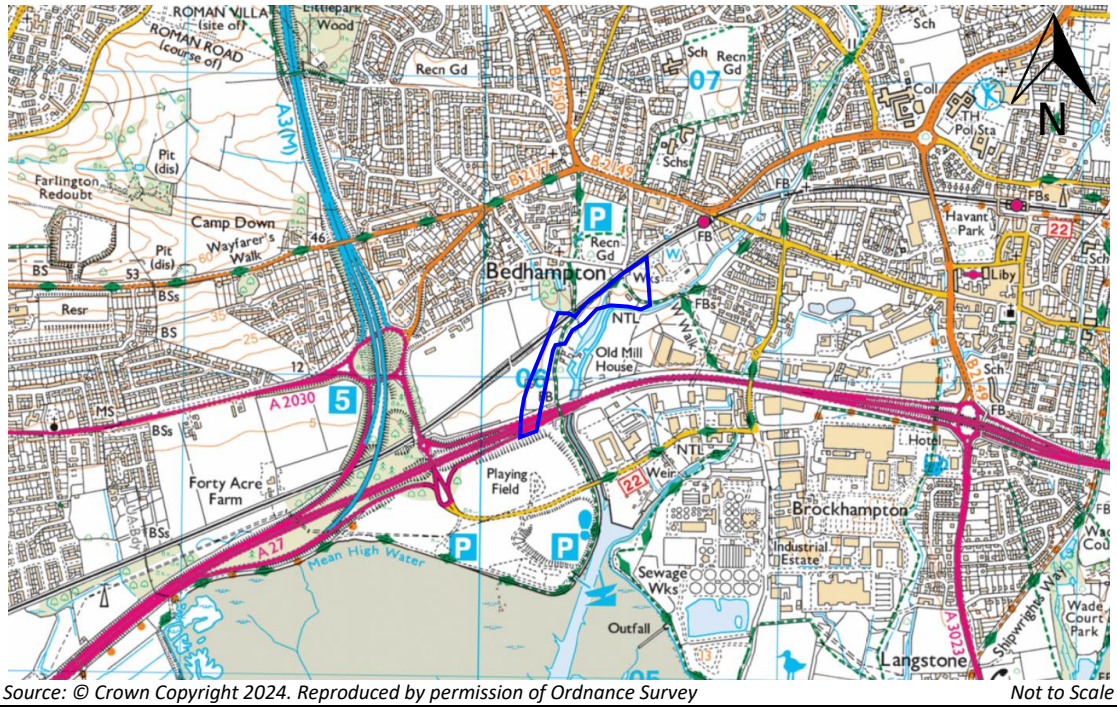
2.1 Site location

The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU 702061. It is located approximately 1.2km west of central Havant.

The Site comprises open ground, and is crossed by the A27, Mill Lane, and a mainline railway. It is bounded to the north by a mainline railway, to the east by open ground and Hermitage Stream, to the south by open ground, and to the west by open ground and a mainline railway.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Military camps and barracks

Several military camps have been identified in the vicinity of the Site. Details are provided below.

3.1.1 Marshalling Area 'A'

In 1944, during preparations for the D-Day invasions of Normandy, a series of Marshalling Areas were established throughout southern England. The War Office (WO) requisitioned land and property, and restricted civilian travel within marshalling areas.

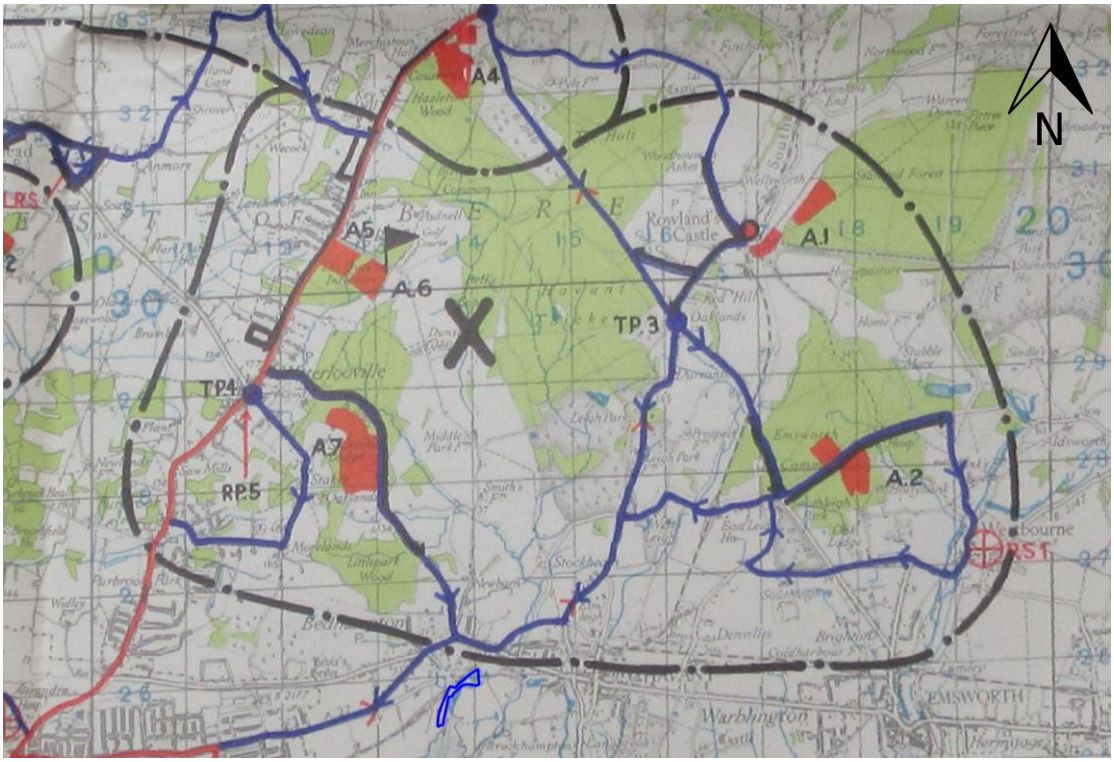
Marshalling areas were typically split into sub-areas, containing embarkation points, military camps, vehicle parks, and stores depots to accommodate the build-up of troops and material prior to D-Day.

The Site was encompassed by Marshalling Area 'A'. Sub-area 'X' within Marshalling Area 'A' included areas of Havant, Bedhampton, and Leigh Park, in the vicinity of the Site.

Figure 2 is a plan dated the 18th April 1944 showing the extents of Sub-area 'X', within approximately 0.2km north of the Site. It also shows troop camps ('A1' – 'A7'), traffic posts (T.P.2 – T.P.4), and roadways allocated to military transport.

No records of camps on or in the vicinity of the Site have been found. The nearest camp was 'A7', approximately 1.7km northwest of the Site.

Figure 2 Plan of Marshalling Sub-area 'X', 18th April 1944



Source: The National Archives *Not to Scale*

Legend			
	Site boundary	Troop camps	Sub-area boundary
	Sub-area HQ	One way route	Two-way route

Ad hoc military training is known to have occurred in D-Day Marshalling Areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on historical aerial photography (see Plate 2).

After WWII, requisitioned land and property was returned to its original ownership and use.

Potential UXO hazard

No records of any military camps, depots, or training encroaching onto the Site have been found.

Due to the concentration of military troops in the vicinity of the Site, the possibility of localised spillage and disposal of UXO on the Site, whilst unlikely, cannot be entirely discounted.

Marshalling Area 'A' is not considered to provide a significant source of UXO hazard to the Site.

3.1.2 Belmont Camp

In 1939, the Royal Navy (RN) requisitioned land at Belmont Park House, approximately 0.4km north-northwest of the Site (see Plate 2), as a transit camp.

The camp comprised 100No. Nissen huts and accommodated approximately 1,500No. troops from the RN and Women's Royal Naval Service (WRNS).

The camp operated as temporary accommodation for RN units awaiting assignment to operational ship crews and as an overflow camp for other barracks and camps in the area.

After WWII, Belmont Camp was used as overflow accommodation for displaced persons at Fraser Camp (see Section 3.1.3), approximately 0.6km northeast of the Site.

In the 1950s, the former Belmont Camp was redeveloped into residential housing.

Belmont Camp is not considered to provide a source of UXO hazard to the Site.

3.1.3 Fraser Camp

In 1941, Fraser Camp was established off New Road, Bedhampton, approximately 0.6km northeast of the Site. The camp comprised 42No. brick huts to accommodate civilians made homeless during air raids on Portsmouth and the surrounding areas.

In 1944, the camp was used to billet troops in the build-up to D-Day (see Section 3.1.1).

After WWII, the camp was used to house displaced persons, mostly from eastern Europe. The camp has since been redeveloped into a housing estate.

Fraser Camp is not considered to provide a source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

0.1 Anti-Aircraft (AA) guns

During WWI, there were 11No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Purbrook (SU 678064), approximately 2.4km west of the Site. It was armed with 1No. 18-pounder (-pdr).

During WWII, there were 14No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Morelands (SU 686070), approximately 1.9km northwest of the Site. It was armed with 4No. 3.7" guns and 1No. GL Mk.II Radar.

The nearest recorded WWII AA shell incident to the Site is described below.

April 1940

1No. AA shell fell on Bedhampton School, approximately 0.2km northeast of the Site. This was recorded as an Unexploded AA (UXAA) shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

0.2 Bombing decoys

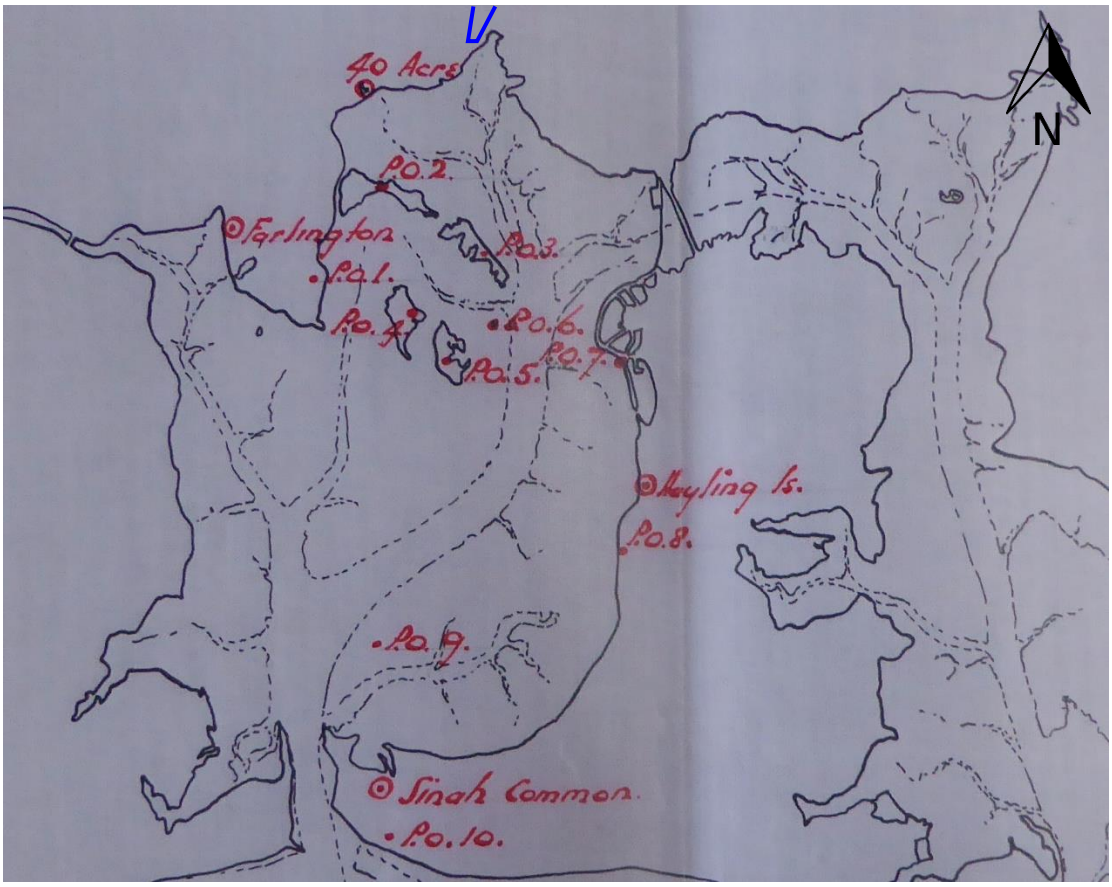
During WWII, 10No. bombing decoys were established in and around Langstone Harbour, in the vicinity of the Site. They were designed to replicate Portsmouth dock and harbour facilities.

The nearest of these was P.O.2, a Quick Light (QL) decoy located at North Binness Island, approximately 1.3km southwest of the Site.

The control centre for 4No. of the Langstone Harbour decoys was established at 40 Acre Farm, approximately 0.9km west-southwest of the Site.

Figure 3 is a map, dating from WWII. It shows location of bombing decoys (P.O.1 – P.O.10) at Langstone Harbour and 3No. control centres at 40 Acres Farm, Hayling Island, and Sinah Common.

Figure 3 Map of Langstone Harbour bombing decoys, WWII



Source: The National Archives *Not to Scale*

Legend	Site boundary

The decoys in Langstone Harbour were effective in diverting German aircraft away from Portsmouth on several occasions.

Records indicate that there were at least 6No. air raids on the Langstone Harbour bombing decoys.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was No. 15 Kite Balloon Base (KBB) at Tipner, approximately 6.7km southwest of the Site. It operated maritime patrols between 1917 and August 1919.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Thorney Island, approximately 6.7km southeast of the Site.

In 1938, RAF Thorney Island was established as a fighter base and used extensively during the Battle of Britain.

In 1943, the airfield was transferred to RAF Coastal Command. It accommodated several units from the RAF, Royal Canadian Air Force (RCAF), and Fleet Air Arm (FAA) flying anti shipping patrols in the English Channel.

After WWII, RAF Thorney Island remained in use as a Royal Observer Corps (ROC) training camp. In 1976, the RAF left the airfield and by 1984 control of the airfield was with the Royal Artillery (RA). The airfield was renamed to Baker Barracks and remains operational.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.5 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.6 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Portsmouth and Havant

The distinctive coastline of the region was a major navigational aid for German bombers on their route to the strategic target areas around Portsmouth, approximately 8.1km southwest of the Site, and further inland. The area around the Site was also subjected to 'tip and run' bombing raids.

From 1939, bombing decoys were established in and around Langstone Harbour to divert German aircraft over the relatively unpopulated island of Hayling and local mudflats (see Section 0.2). On the 17th April 1941, a decoy on Sinah Commons, approximately 6.5km south of the Site, attracted such an intense level of bombing that it became known as the most successful decoy of the war.

There were 69No. recorded air raids on Portsmouth. In total, approximately 1,262No. High Explosive (HE) bombs were reported falling within the city boundaries, approximately 8.1km southwest of the Site.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including aircraft manufacturing, military camps and barracks, major transport infrastructure, and Brockhampton Water Works.

The nearest identified Luftwaffe target was Portsmouth Water Co. works, approximately 2.1km west of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Havant & Waterloo UD	**375**	**39**	**9**	**423**	**35.0**
Portsmouth CB	1,221	34	7	1,262	136.8
Chichester RD	1,154	38	29	1,221	11.9
Petersfield RD	457	9	19	485	8.6

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

9th September 1940

1No. HE bomb fell on Manor House, Bedhampton, approximately 0.2km north-northwest of the Site. This was recorded as an UXB.

30th September 1940

1No. HE bomb fell on Bedhampton Chalk Pit, Portsdown Hill Road, approximately 0.6km west-northwest of the Site.

11th November 1940

Several IBs fell on open ground south of Manor Farm, Bedhampton, approximately 0.5km west of the Site.

11th March 1941

1No. HE bomb fell on the searchlight field at Langstone Road, Havant, approximately 1.1km east-

southeast of the Site.

21st August 1942

4No. HE bombs fell on Ranelagh Road, within approximately 0.4km east of the Site.

8th March 1943

1No. Oil Bomb (OB) fell on Portsdown Hill, approximately 0.4km northwest of the Site.

15th August 1943

3No. HE bombs fell on the foreshore near Forty Acre Farm, within approximately 0.8km west-southwest of the Site.

15th – 16th August 1943

2No. HE bombs fell in the sea at Broad Marsh, approximately 0.3km south-southwest of the Site.

Several IBs fell on Broad Marsh, between approximately 0.2km and 0.4km southwest of the Site.

16th August 1943

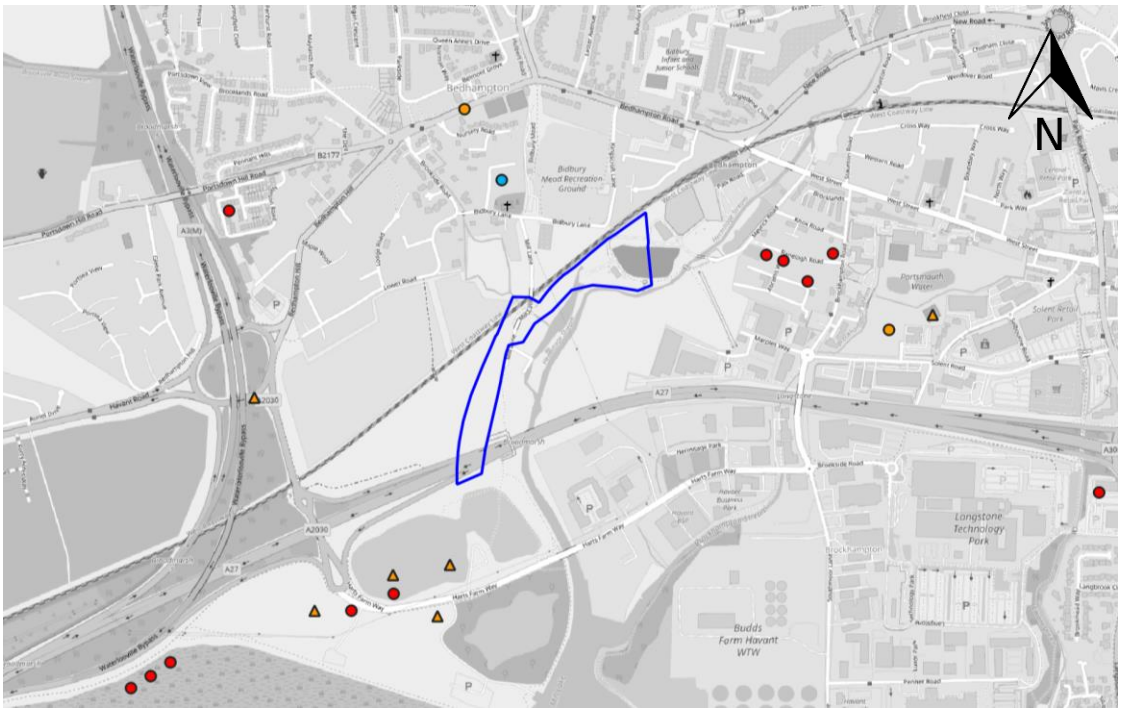
1No. OB and several IBs fell on open ground near Brockhampton Water Works, approximately 0.5km east of the Site.

Figure 4 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R12-MAP01-A.

Figure 4 Compiled bomb impact map for the vicinity of the Site



Source: OpenStreetMap *Not to Scale*

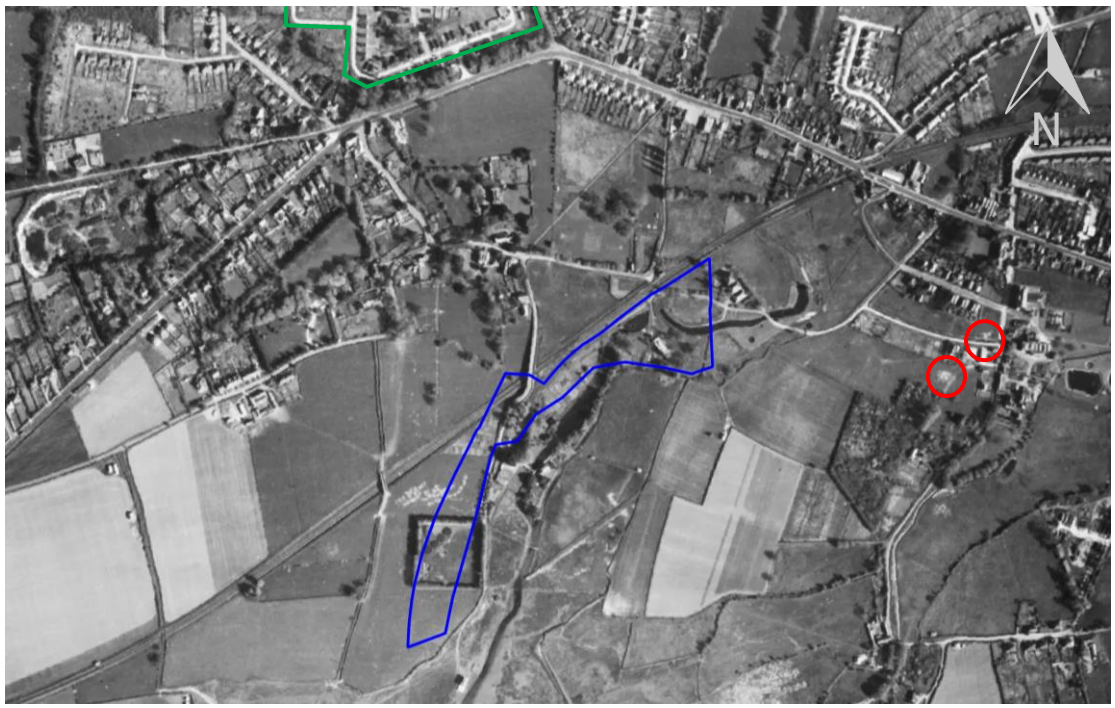
Legend	Site boundary	HE bomb	UXB	OB	IBs

Plate 2 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site. Some agricultural markings can be seen on the Site.

Possible bomb damage has been identified to the east of the Site.

Belmont Camp (see Section 3.1.2) has also been identified.

Plate 2 Aerial photograph, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Belmont Camp	Possible bomb damage

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage or cratering has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground and railway embankment, over alluvial and river terrace deposits, overlying the White Chalk Subgroup.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 7m of clay, over 3m of soft chalk, overlying more than 20m of firm chalk.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	5.5m
	250kg	8.5m
	500kg	11.5m

Where railway ballast was present, the estimated average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

WO statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds the following records of post-WWII EOC tasks having taken place in the vicinity of the Site.

17th April 2019

1No. unexploded shell was discovered at the Havant Waste Recycling Centre, approximately 0.3km southeast of the Site. It was removed and disposed of by the RN.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

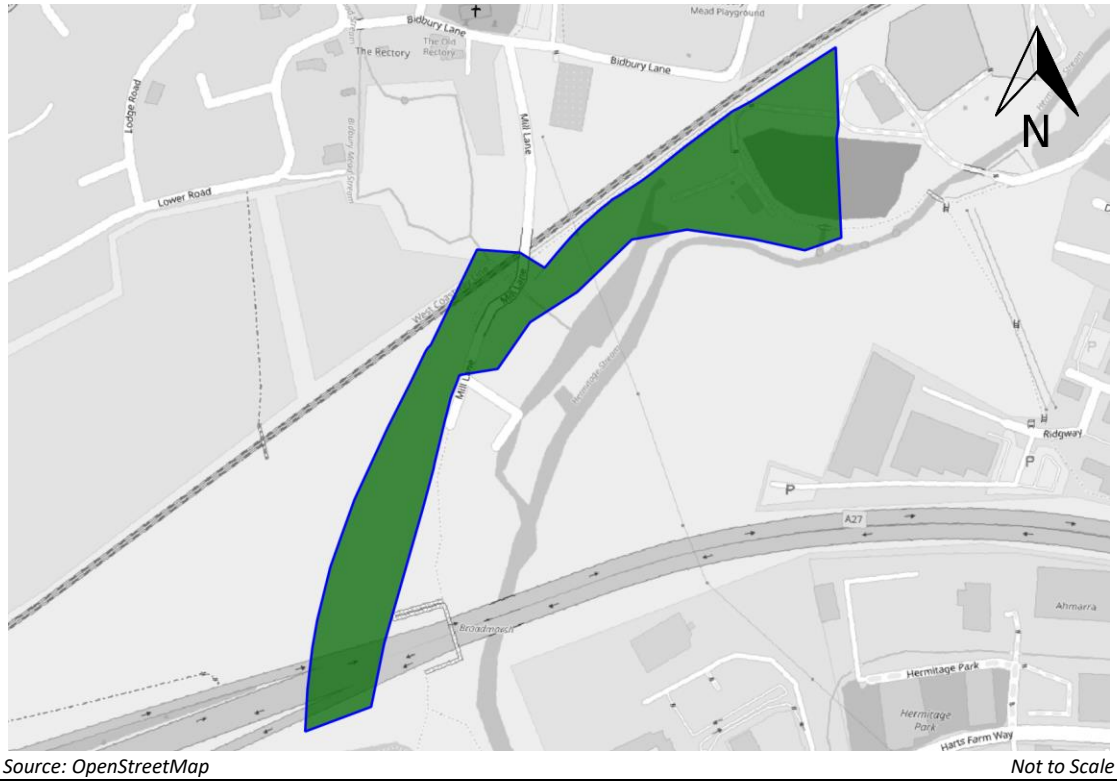
Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 5.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R12-MAP01-A.

Figure 5 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

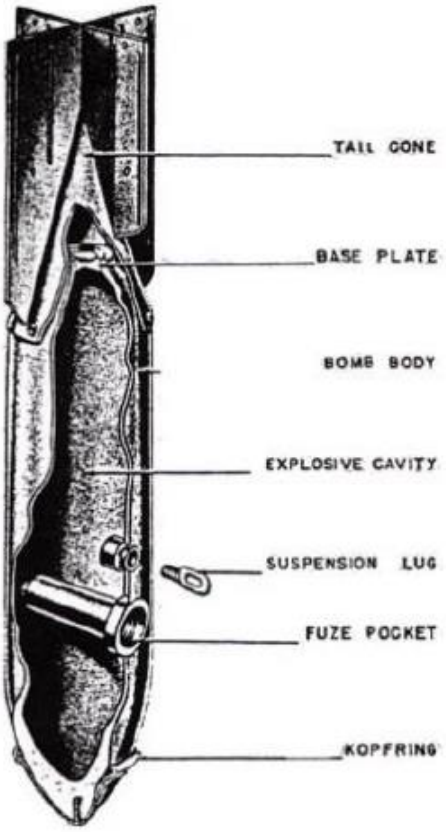
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



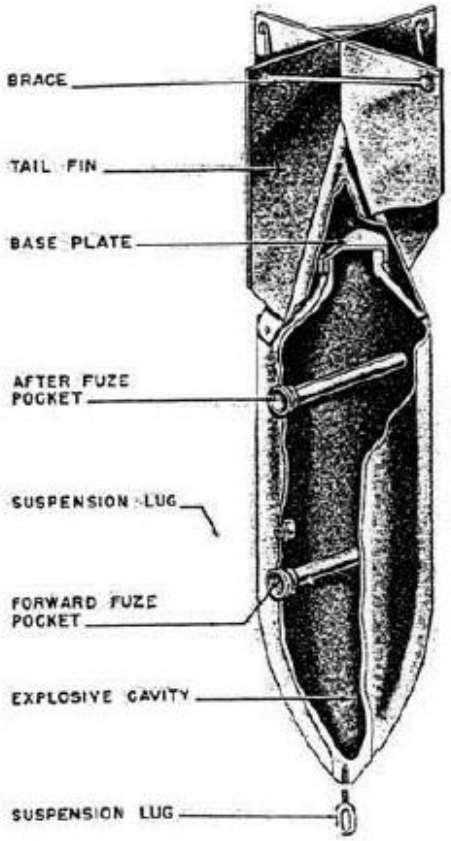




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



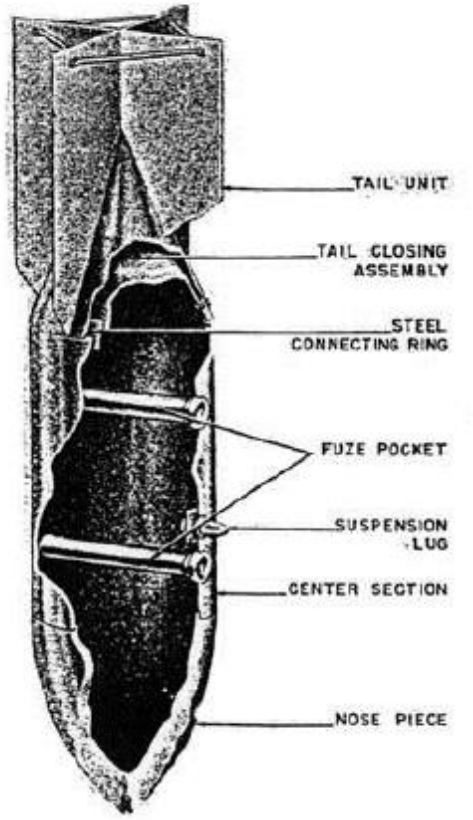




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

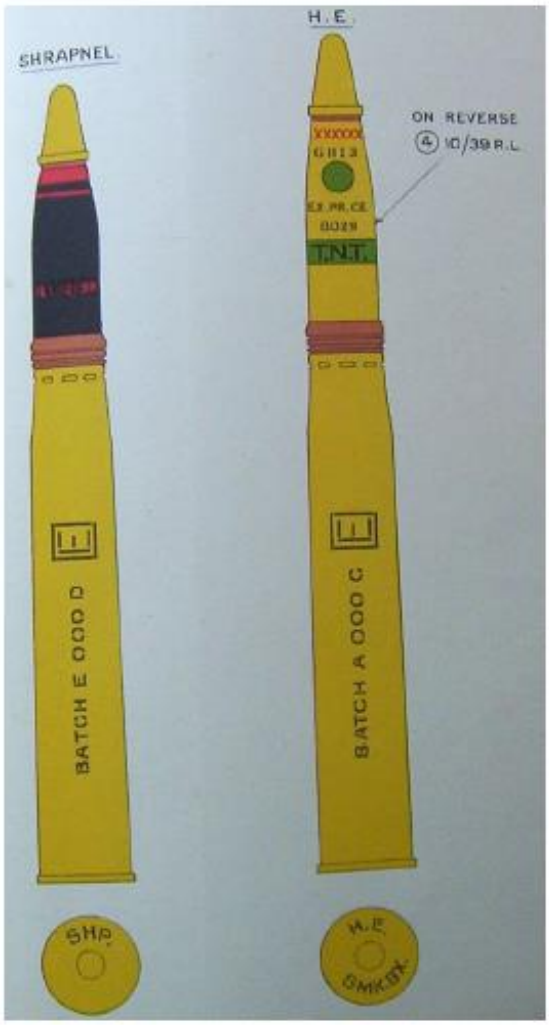
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

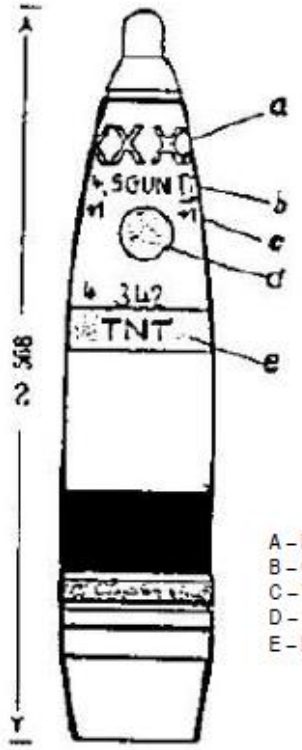
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

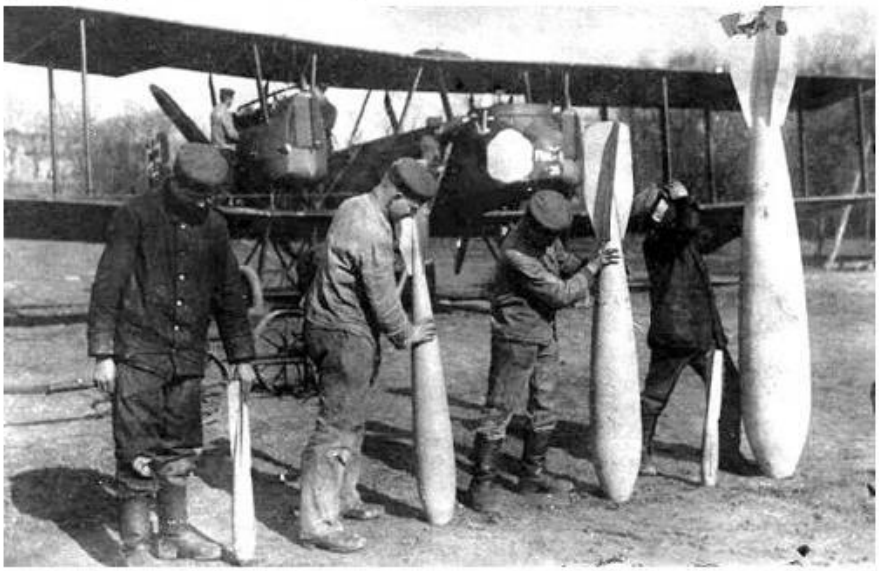
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Brookes R J, Airfields in the Second World War, Hampshire, 1996

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Leete J, In Time of War Hampshire, 2006

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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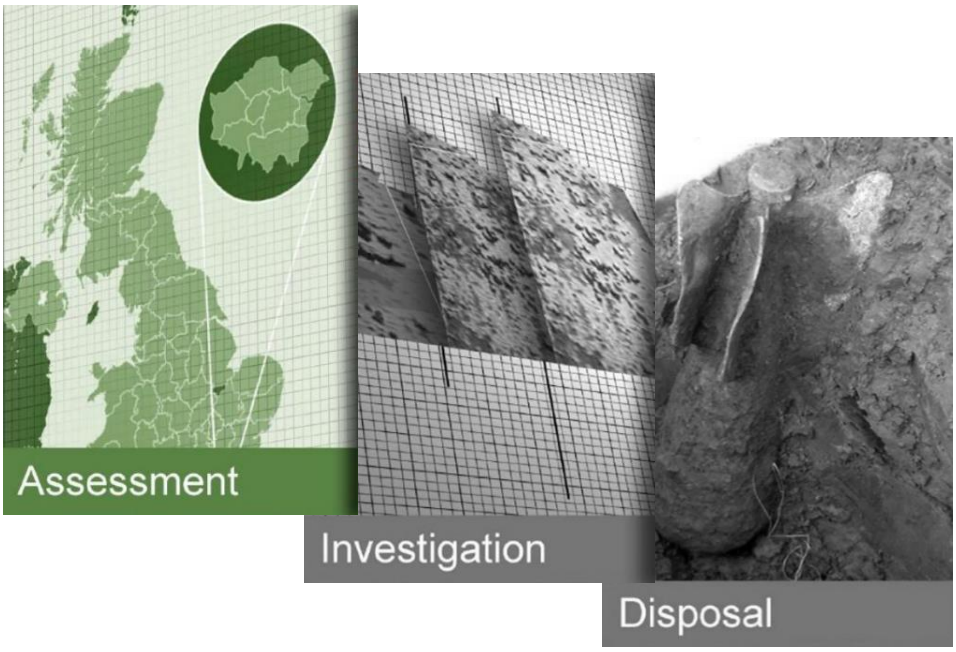
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]

zeticaUXO



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R1**
Revision	**A**
Project Title	**Havant Thicket Pipeline**
Client	**Southern Water**
Date	**5th April 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: An UXO awareness briefing is recommended for staff involved in excavations.

UXO hazard assessment

During World War Two (WWII), troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the northern part of the Site. No records have been found indicate live munitions were used, although the possibility cannot be totally discounted.

In 1944, Havant Thicket was used as an assembly point for troops, equipment, vehicles, and tanks, as preparation for the 'D-Day' landings in occupied France.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the northern part of the Site, whilst unlikely, cannot be entirely discounted.

Military activity on Havant Thicket is not considered to provide a significant source of UXO hazard to the Site.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 6 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R1-MAP01-A.

It should be noted that the potential to encounter UXO anywhere across a former marshalling area assembly point cannot be discounted. If UXO is found, a re-assessment of the hazard level is required.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low	Moderate	
	High		Very High		

The main findings of the report are summarised below.

- During WWII, troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the northern part of the Site.
- By 1941, Stockheath Naval Camp was established on land encroaching on the northern part of the Site. This was designated as an accommodation camp.
- In 1941, Fraser Camp was established on land encroaching on the southern part of the Site. The camp was used to accommodate bombed out civilians from Portsmouth.
- By 1943, His Majesty's Ship (HMS) Daedalus III, was established on land encroaching on the southern part of the Site. The camp operated as a satellite accommodation camp to Royal Naval Air Station (RNAS) Lee-on-the-Solent.
- During 1944, Havant Thicket was used as an assembly point as part of preparations for the 'D-Day' landings in occupied France. Several military units and equipment, tanks, and military vehicles were present at Havant Thicket.
- By the 1950s, HMS Daedalus III, Fraser Camp, and Stockheath Camp were demolished for the development of residential buildings.
- During WWII the main strategic targets in the vicinity of the Site included military camps and barracks, and Portsmouth Water Company.

- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 0.2km east of the Site of the Site, on the 11th September 1940.
- There were 12No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they can take appropriate action in the event of a suspect find.

What do I do next?

If you require a quote for an awareness briefing or further assistance, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS data

P14032-24-R1-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AME	Admiralty Mining Establishment
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BDU	Bomb Disposal Unit
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FAA	Fleet Air Arm
HAA	Heavy Anti-Aircraft
HE	High Explosive
HER	Historic Environment Record
HMS	His Majesty's Ship
HQ	Headquarters
IB	Incendiary Bomb
IWM	Imperial War Museum
KBB	Kite Balloon Base
LAA	Light Anti-Aircraft
MDD	Mine Design Department
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RA	Royal Artillery
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RE	Royal Engineers
RM	Royal Marines
RN	Royal Navy
SAA	Small Arms Ammunition
UCWE	Underwater Countermeasures and Weapons Establishment
UK	United Kingdom
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WRNS	Women's Royal Naval Service
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route totalling approximately 5.3km between Havant Thicket and Bidbury Lane, in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Archives and Local Studies, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

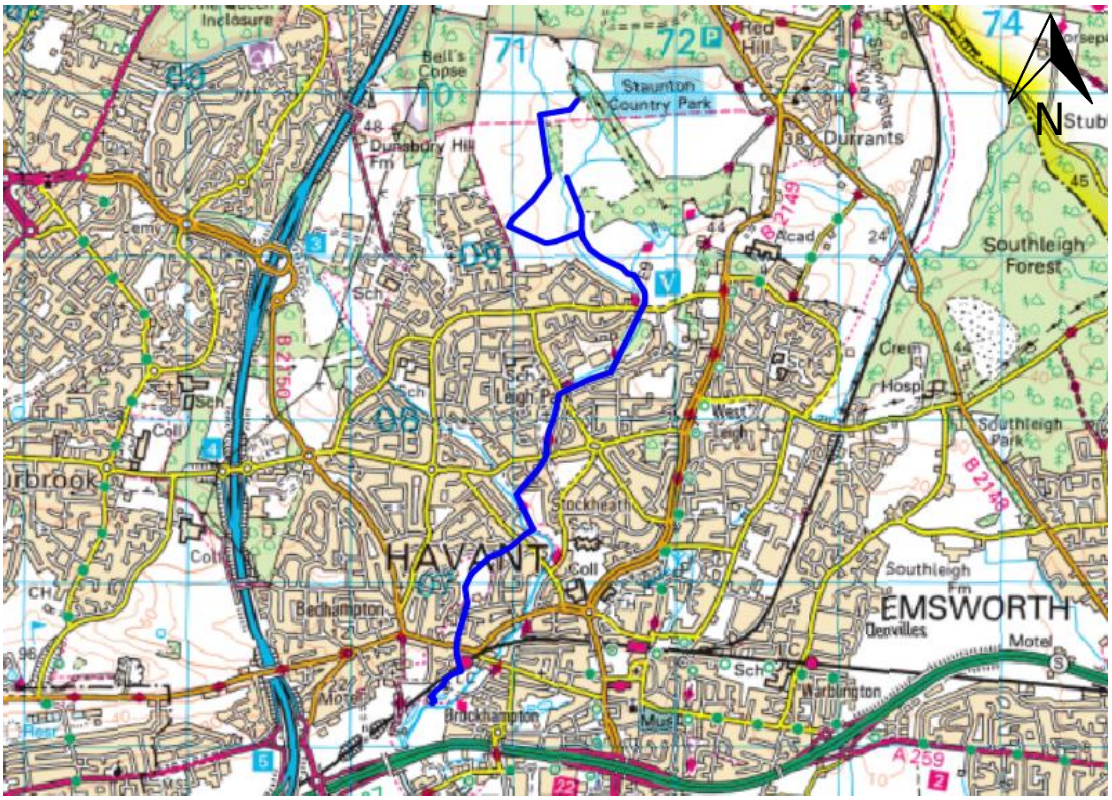
2.1 Site location

The Site commences at Havant Thicket (SU 713099) and terminates at Bidbury Lane (SU 704063). It is located approximately 7.1km northeast of central Portsmouth.

The Site comprises open ground, hardstanding, roadways, and is crossed by the West Coastway railway line. It is bounded to the north by open ground and woodland, and to the east, south, and west by hardstanding, roadways, commercial and residential buildings.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Military camps and marshalling areas

Several military camps and marshalling areas have been identified in the vicinity of the Site. Details are provided below.

3.1.1 Marshalling Area 'A'

In 1944, during preparations for the 'D-Day' landings in occupied France, a series of Marshalling Areas were established throughout southern England. The War Office (WO) requisitioned land and property, and restricted civilian travel within marshalling areas.

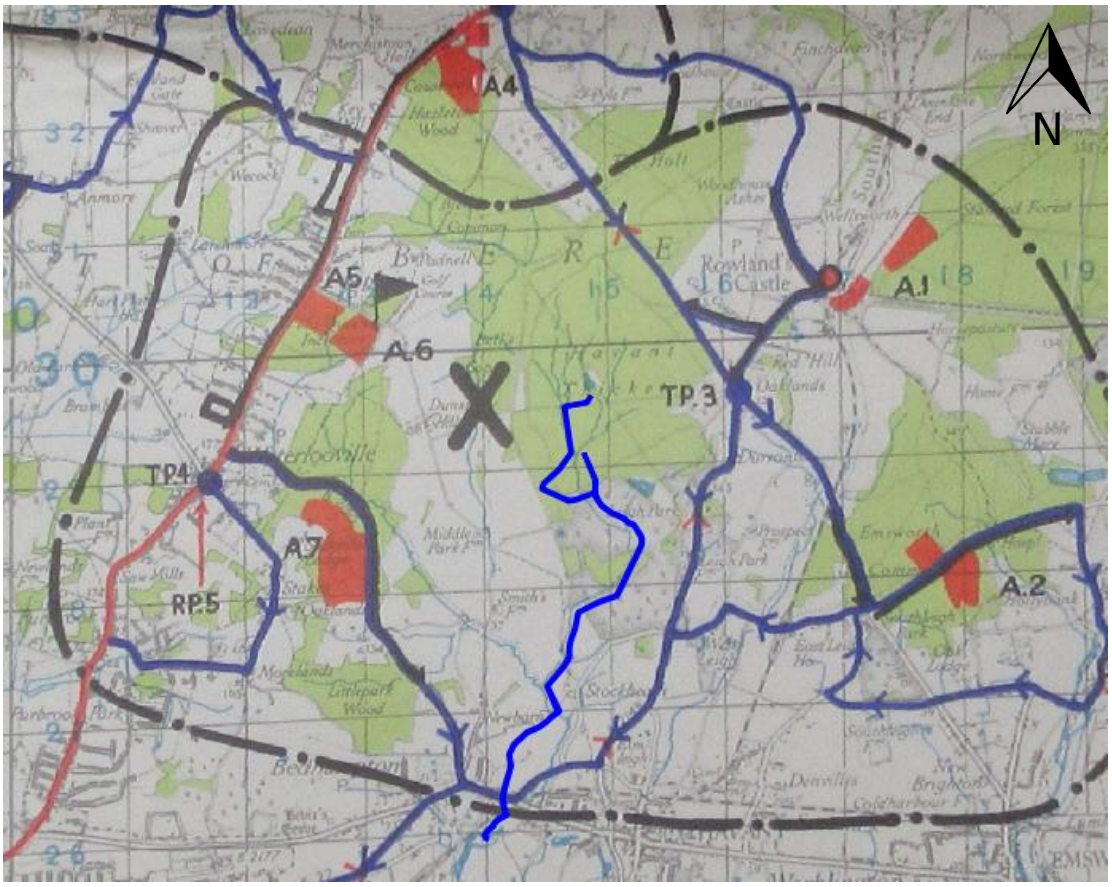
Marshalling areas were typically split into sub-areas, containing embarkation points, military camps, vehicle parks, and stores depots to accommodate the build-up of troops and material prior to D-Day.

The Site was encompassed by Marshalling Area 'A'. Sub-area 'X', within Marshalling Area 'A', included areas of Havant, Bedhampton, and Leigh Park, in the vicinity of the Site.

Figure 2 is a plan dated the 18th April 1944 showing the extents of Sub-area 'X', encompassing the Site. It also shows troop camps ('A1' – 'A7'), traffic posts (T.P.2 – T.P.4), and roadways allocated to military transport.

No records of camps on the Site have been found. The nearest camp was 'A7', Stakes Hill, approximately 1.5km west of the Site. Camp 'A7' accommodated 2,500No. men and 250No. vehicles from 1st Battalion, Kings Own Scottish Borderers.

Figure 2 Plan of Marshalling Sub-area 'X', 18th April 1944



Source: The National Archives *Not to Scale*

Legend			
	Site boundary	Troop camps	Sub-area boundary
	Sub-area HQ	One way route	Two-way route

During 1944, Havant Thicket, on the northern part of the Site, was used as an assembly point. Records indicate several military units and equipment, tanks, and military vehicles were present at Havant Thicket.

Ad hoc military training is known to have occurred in D-Day Marshalling Areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on historical aerial photography (see Plates 4 - 7).

After WWII, requisitioned land and property was returned to its original ownership and use.

In June 2023, metal detectorists conducted a search of Havant Thicket, on the northern part of the Site. Remnants from military activities were found, although no further details were provided. It is considered unlikely these items were UXO.

Potential UXO hazard

In 1944 Havant Thicket was used as an assembly point for troops, equipment, and vehicles as preparation for the invasion of occupied France.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the northern part of the Site, whilst unlikely, cannot be entirely discounted.

It is considered that any remnant munitions present at Havant Thicket are likely to have been removed during subsequent tree felling activities in Havant Thicket post-WWII.

Marshalling Area 'A' is not considered to provide a significant source of UXO hazard to the Site.

3.1.2 Stockheath Naval Camp

In 1941, Stockheath Naval Camp was established on land near Riders Lane, encroaching onto the northern part of the Site.

Stockheath Naval Camp was initially used as a Royal Naval (RN) overflow camp for Portsmouth Naval Barracks, approximately 8.8km southwest of the Site. Throughout WWII, the camp was also used as a RN survivors recuperation camp.

The camp covered an area of 200ha and comprised of several Nissen nuts and an assault course, adjacent to the northern part of the Site (see Plate 2).

Stockheath Naval Camp also accommodated a detachment of Royal Marines (RMs). Records indicate the RMs would carry out training exercises in the surrounding fields, in the immediate vicinity of the Site.

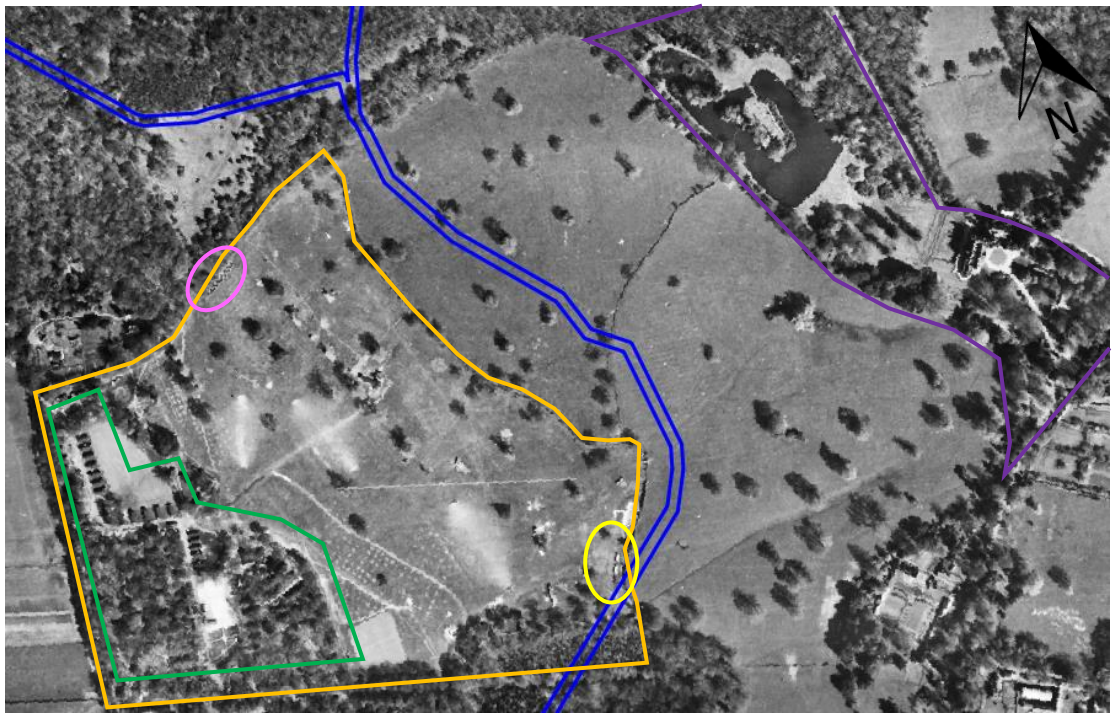
The camp was also used to provide a 'flying column' in the event of invasion. The flying column was an ad-hoc unit of 100No. men that could be rapidly mobilised.

In March 1942, the flying column took part in an anti-invasion training exercise at the camp, in the vicinity of the Site, with the army and local Home Guard units (see Section 3.3.2). Troops involved in the training exercise were issued with rifles and live ammunition. This would likely have comprised Small Arms Ammunition (SAA).

Plate 2 is an aerial photograph dated the 19th April 1946. The extents of Stockheath Camp, 1No. practice trench, Nissen huts, and the assault course have been identified.

Leigh Park House has also been identified (see Section 3.1.5).

Plate 2 Aerial photograph, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Stockheath Camp	Assault course
	Leigh Park House	Nissen huts	Practice trench

After WWII, Stockheath Camp was abandoned and was demolished. During the 1950s a section of the camp was redeveloped into a residential estate.

In the 1960s, the remainder of the former camp was purchased and redeveloped into the Great Copse estate.

Stockheath Naval Camp is not considered to provide a significant source of UXO hazard to the Site.

3.1.3 His Majesty's Ship (HMS) Daedalus III

In March 1943, HMS Daedalus III was established off Park Lane, Bedhampton, encroaching on to the western part of the Site.

The camp was established by the Fleet Air Arm (FAA) as a satellite camp to the Royal Naval Air Station (RNAS) Lee-on-the-Solent, approximately 14.2km southwest of the Site.

HMS Daedalus III comprised 80No. Nissen huts, which were used as accommodation and administration buildings. The camp could accommodate at least 1,000No. men.

Plate 3 is an aerial photograph dated the 19th April 1946. The extents of HMS Daedalus III have been identified.

Fraser Camp (see Section 3.1.4) and Belmont Camp (see Section 3.1.6) have also been identified.

Plate 3 Aerial photograph, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	HMS Daedalus III
	Fraser Camp	Belmont Camp

After WWII, the camp was used to house displaced persons from the Baltic states. By the 1950s the camp was demolished and has since been redeveloped into a residential estate

HMS Daedalus III is not considered to provide a source of UXO hazard to the Site.

3.1.4 Fraser Camp

In 1941, Fraser Camp was established off New Road, Bedhampton, encroaching onto the eastern part of the part of the Site (see Plate 3). The camp comprised 42No. brick huts to accommodate civilians made homeless during air raids on Portsmouth and the surrounding areas.

In 1944, the camp was used to billet troops in preparation for the 'D-Day' landings in occupied France (see Section 3.1.1).

After WWII, the camp was used to house displaced persons from the Baltic states.

By 1955, Fraser Camp was demolished and has since been redeveloped into a residential estate.

Fraser Camp is not considered to provide a source of UXO hazard to the Site.

3.1.5 Leigh Park House

On the 30th August 1940 Leigh Park House, approximately 0.2km east of the Site, was requisitioned by the Admiralty Mine Design Department (MDD) (see Plate 2).

Previously stationed at HMS Vernon, approximately 9.7km southwest of the Site, Leigh Park House became the Headquarters (HQ) and administrative centre for MDD sections responsible for the design of mines, depth changes and minesweeping.

An MDD research section was also established at West Leigh House, approximately 0.9km east-southeast of the Site. Naval staff responsible for the trials of MDD equipment were accommodated at West Leigh Cottage, approximately 0.9km east-southeast of the Site.

Leigh Park House was equipped with several Nissen huts, and various buildings of the house were repurposed. The icehouse, approximately 0.2km east-northeast of the Site, was repurposed as a magazine to store explosives.

The grounds of the house, in the vicinity of the Site, were used for various tests, with magnetic mine tests in a magnetic hut. The Lake at Leigh Park, approximately 0.2km east of the Site, was used for under-water experiments.

Leigh Park House also had its own Home Guard based in Leigh Park, on the northern part of the Site (see Section 3.3.2). Records indicate the Home Guard conducted manoeuvres on parkland and the surrounding woodland of Leigh Park.

After WWII, the Admiralty remained at Leigh Park House, with the grounds of Leigh Park being sold to Portsmouth City Council. In 1946, HMS Vernon's MDD was reconstituted at Leigh Park House as the Admiralty Mining Establishment (AME).

In 1951, the AME was renamed the Underwater Countermeasures and Weapon Establishment (UCWE), focusing on the design of anti-submarine weapons and sensors.

In 1957, the Admiralty vacated Leigh Park House, which was demolished in 1959.

Leigh Park House and grounds are not considered to provide a significant source of UXO hazard to the Site.

3.1.6 Belmont Camp

In 1939, the RN requisitioned land at Belmont Park House, approximately 0.4km west of the Site, as a transit camp (see Plate 3).

The camp comprised 100No. Nissen huts and accommodated approximately 1,500No. troops from the RN and Women's Royal Naval Service (WRNS).

The camp operated as temporary accommodation for RN units awaiting assignment to operational ship crews and as an overflow camp for other barracks and camps in the area.

After WWII, Belmont Camp was used as overflow accommodation for displaced persons at Fraser Camp (see Section 3.1.4).

In the 1950s, the former Belmont Camp was redeveloped into residential housing.

Belmont Camp is not considered to provide a source of UXO hazard to the Site.

3.2 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

[redacted]

Other than those detailed in Section 3.1, no records of any firing ranges or live military training areas on the Site have been found. The nearest is detailed below.

3.2.1 Stansted Park

On the 13th April 1942, a Canadian Battle Training School was established at Stansted Park, approximately 2.5km northeast of the Site.

The school provided troops with Battle Drill Training, comprising physical training, fieldcraft, and battle inoculation, which involved realistic training in a simulated battle scenario using live ammunition.

Lectures, demonstrations, and practice sessions took place within the grounds of Stansted Park. The school's training also took place at several other locations including beach landings at Hayling Island, approximately 6.4km south of the Site, and battle inoculation at Gravel Hill, approximately 7.7km north of the Site.

Records indicate that troops stationed at Stansted Park undertook stealth training exercises, including 'stalking' training at Havant Thicket. No records have been found to indicate live munitions were used during the exercises.

In September 1942, the school at Stansted Park was closed and moved to Windlesham House, approximately 40.2km east of the Site.

In 1944, Stansted Park was repurposed as camp 'A1' as part of preparations for the 'D-Day' landings in occupied France (see Section 3.1.1).

Potential UXO Hazard

No evidence has been found indicating that troops stationed at Stansted Park used live munitions during stealth exercises on Havant Thicket, although the possibility cannot be totally discounted.

Stansted Park military training is not considered to provide a significant source of UXO hazard to the Site.

3.3 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

[redacted]

No military defences have been identified on the Site. The nearest are described below.

3.3.1 Anti-Aircraft (AA) guns

During WWI there were 8No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Purbrook (SU 678064), approximately 2.9km west of the Site. It was armed with 1No. 18-pounder (pdr) gun.

During WWII there were 12No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Prospect Farm (SU 728091), approximately 1km east of the Site. Its armaments are unknown.

The nearest recorded WWII AA shell incident to the Site is described below.

April 1941

1No. AA shell fell on Bedhampton School, approximately 0.1km west of the Site. This was recorded as an Unexploded AA (UXAA) shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.3.2 Home Guard

During WWII, the 16th (Havant) Hampshire Home Guard Battalion operated in the vicinity of the Site.

The Home Guard was responsible for patrolling local transport links and strategic targets, as well as manning regional anti-invasion defences.

During WWII Home Guard troops were involved in anti-invasion exercises at Stockheath Camp, encroaching on the northern part of the Site (see Section 3.1.1).

Leigh Park House, approximately 0.2km east-northeast of the Site, also had its own Home Guard based at the park (see Section 3.1.5). The unit performed training manoeuvres on the parkland and the surrounding woodland of Leigh Park, on the Site.

No evidence has been found indicating the manoeuvres at Leigh Park involved live munitions, although the possibility cannot be totally discounted.

Potential UXO Hazard

It should be noted that records of Home Guard activities were rarely kept, and training activities were usually unofficial or unsanctioned.

Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often buried or dumped in ad-hoc locations.

Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

3.3.3 Bombing decoys

The nearest recorded bombing decoy was located at North Binness Island (SU 695046) approximately 1.9km southwest of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.4 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was No. 15 Kite Balloon Base (KBB) at Tipner, approximately 7.3km southwest of the Site. It operated maritime patrols between 1917 and August 1919.

After WWI, the No. 15 KBB was closed.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Thorney Island, approximately 6.8km southeast of the Site.

In 1938, RAF Thorney Island was established as a fighter base and used extensively during the Battle of Britain.

In 1943, the airfield was transferred to RAF Coastal Command. It accommodated several units from the RAF, Royal Canadian Air Force (RCAF), and FAA flying anti shipping patrols in the English Channel.

After WWII, RAF Thorney Island remained in use as a Royal Observer Corps (ROC) training camp. In 1976, the RAF left the airfield and by 1984 control of the airfield was with the Royal Artillery (RA). The airfield was renamed to Baker Barracks and remains operational.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.5 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.6 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.3 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids on Hampshire began in the summer of 1940 and continued until the end of WWII. Over one third of the total number of bombs fell on Southampton, approximately 29.5km west of the Site, and Portsmouth, approximately 6.9km southeast of the Site.

Rural areas remained at risk of bombing. This often comprised 'tip and run' or opportunity attacks by small groups of aircraft. Other bombs were jettisoned by aircraft enroute to or returning from targets elsewhere in the UK.

From 1944, Hampshire was also at risk from the Pilotless Aircraft (V1) offensive. These weapons were highly inaccurate and often missed their intended targets by several kilometres.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precautions (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including military camps and barracks, and Portsmouth Water Company.

The nearest identified Luftwaffe target was Portsmouth Water Company, approximately 2.3km west of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for V1s and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Havant & Waterloo UD	**375**	**39**	**9**	**423**	**35.0**
Petersfield RD	**457**	**9**	**19**	**485**	**8.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Chichester RD	1,154	38	29	1,221	11.9
Droxford RD	599	38	26	663	10.6
Petersfield UD	18	0	2	20	7.2
Midhurst RD	268	0	11	279	4.2

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further recorded bombing incidents in the vicinity of the Site.

9th September 1940

1No. High Explosive (HE) bomb fell on Manor House, Bedhampton, approximately 0.3km west of the Site. This was recorded as an UXB.

11th September 1940

1No. HE bomb fell on High Lawn, Leigh Park, approximately 0.2km east of the Site.

29th September 1940

24No. IBs fell on Leigh Park, approximately 60m east of the Site.

30th September 1940

5No. IBs fell on the pasture fields of Smith's Farm, adjacent to the Site.

29th October 1940

10No. HE bomb fell on the grounds of Leigh Park Farm, approximately 0.3km east of the Site. 1No. of these was recorded as an UXB.

16th January 1941

1No. HE bomb fell on a field near Park Lane, approximately 0.3km west of the Site.

17th January 1941

2No. HE bombs fell on fields near Stockheath Farm, approximately 0.2km east of the Site.

11th April 1941

4No. HE bombs fell on Havant Thicket, approximately 0.3km northeast of the Site.

14th June 1941

1No. HE bomb fell on High Lawn, near Leigh Park House, approximately 0.3km east of the Site. This was recorded as an UXB.

21st August 1942

4No. HE bombs fell on Ranelagh Road, approximately 0.2km east of the Site.

16th August 1943

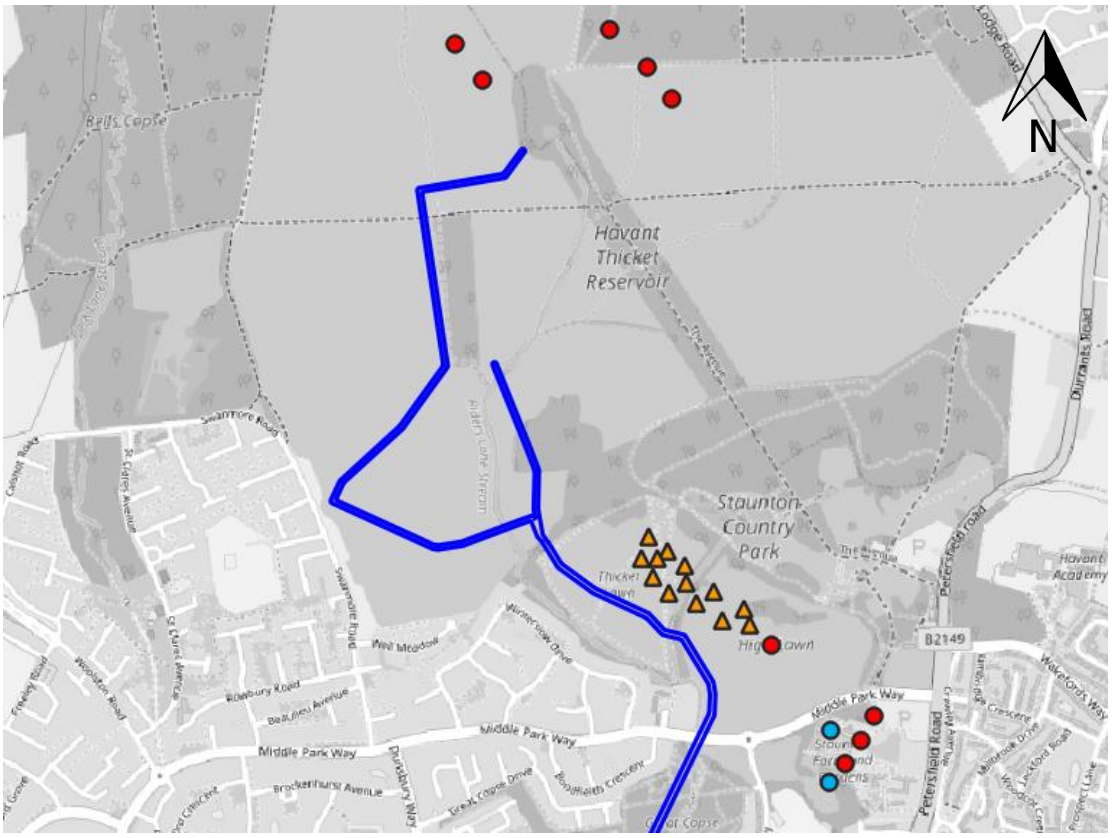
2No. HE bombs fell on Havant Thicket, approximately 0.2km north of the Site.

Figure 3 - 5 are maps showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

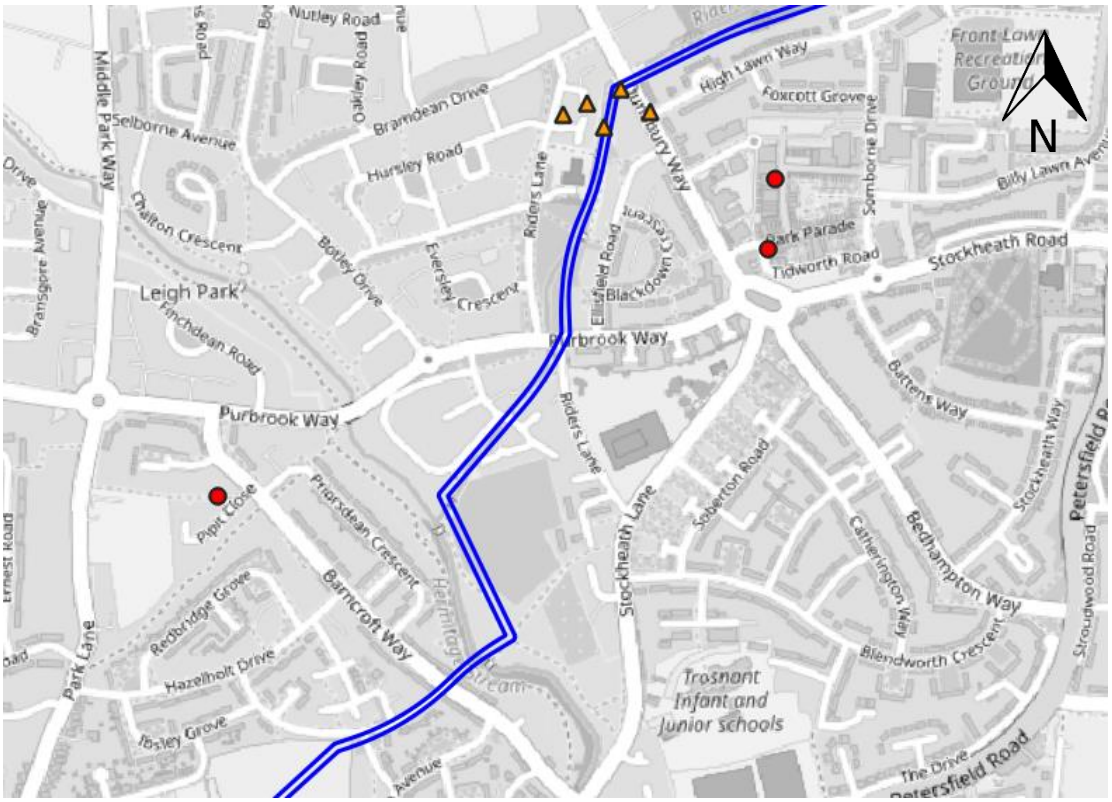
The bomb map is also given in the accompanying P14032-24-R1-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the northern part of Site



Source: OpenStreetMap *Not to Scale*

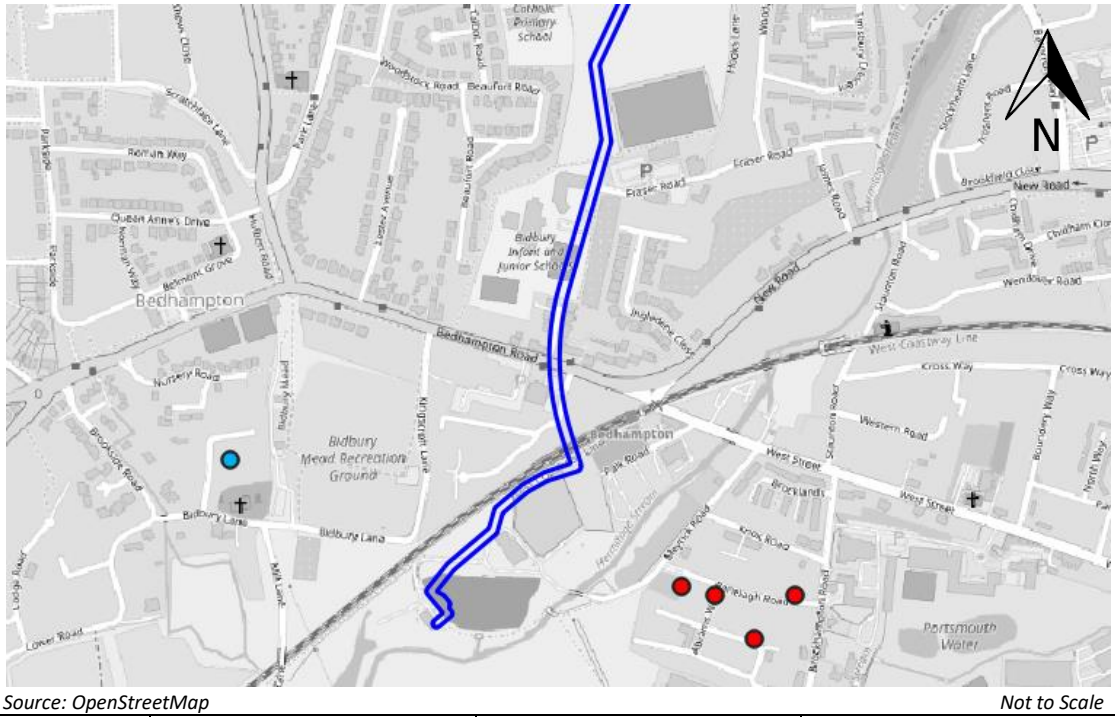
Figure 4 Compiled bomb impact map for the vicinity of the central part of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	IBs

Figure 5 Compiled bomb impact map for the vicinity of the southern part of the Site



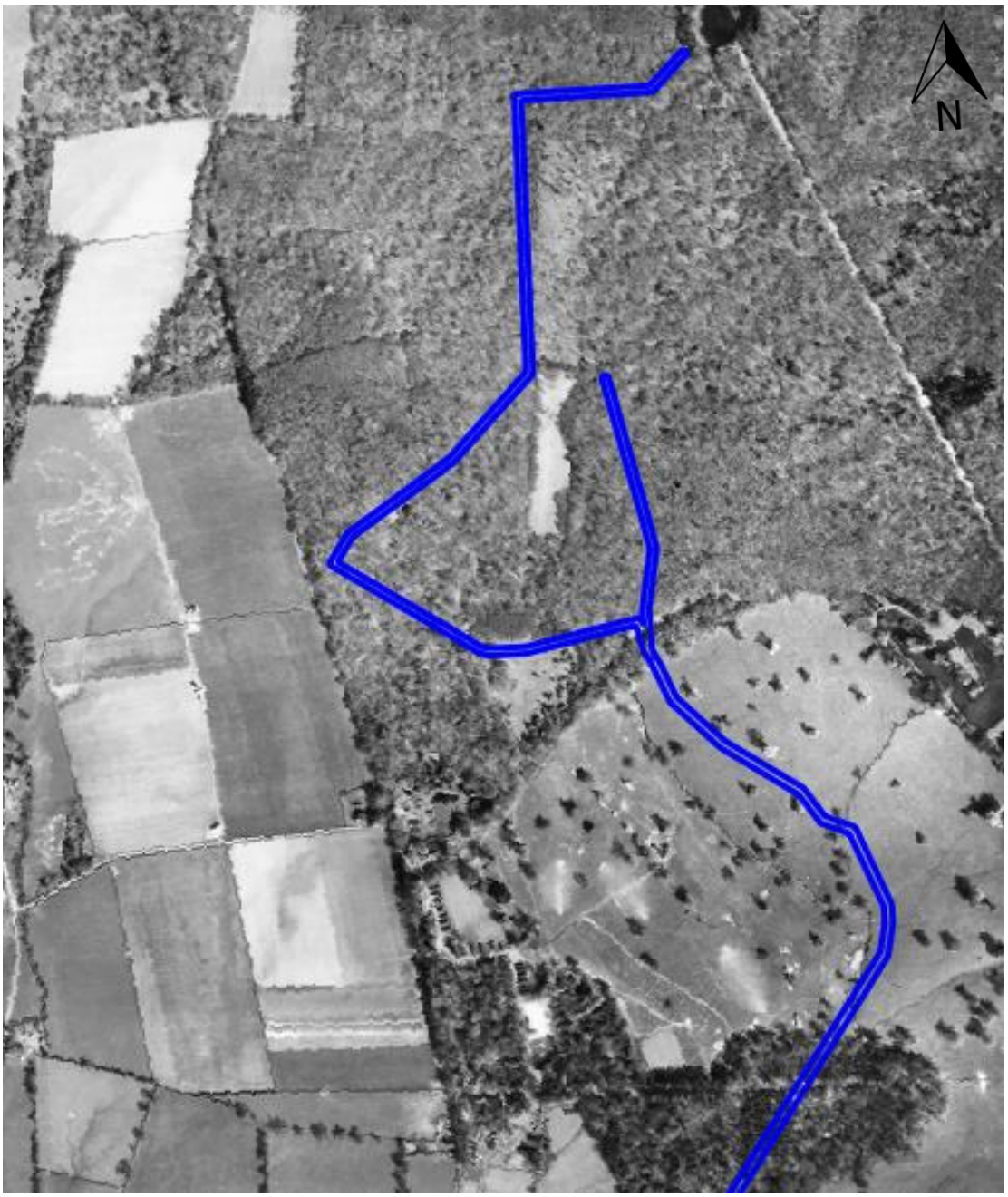
Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB

Plate 4 - 7 are aerial photographs dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

Some bomb damage and cratering has been identified in the vicinity of the Site.

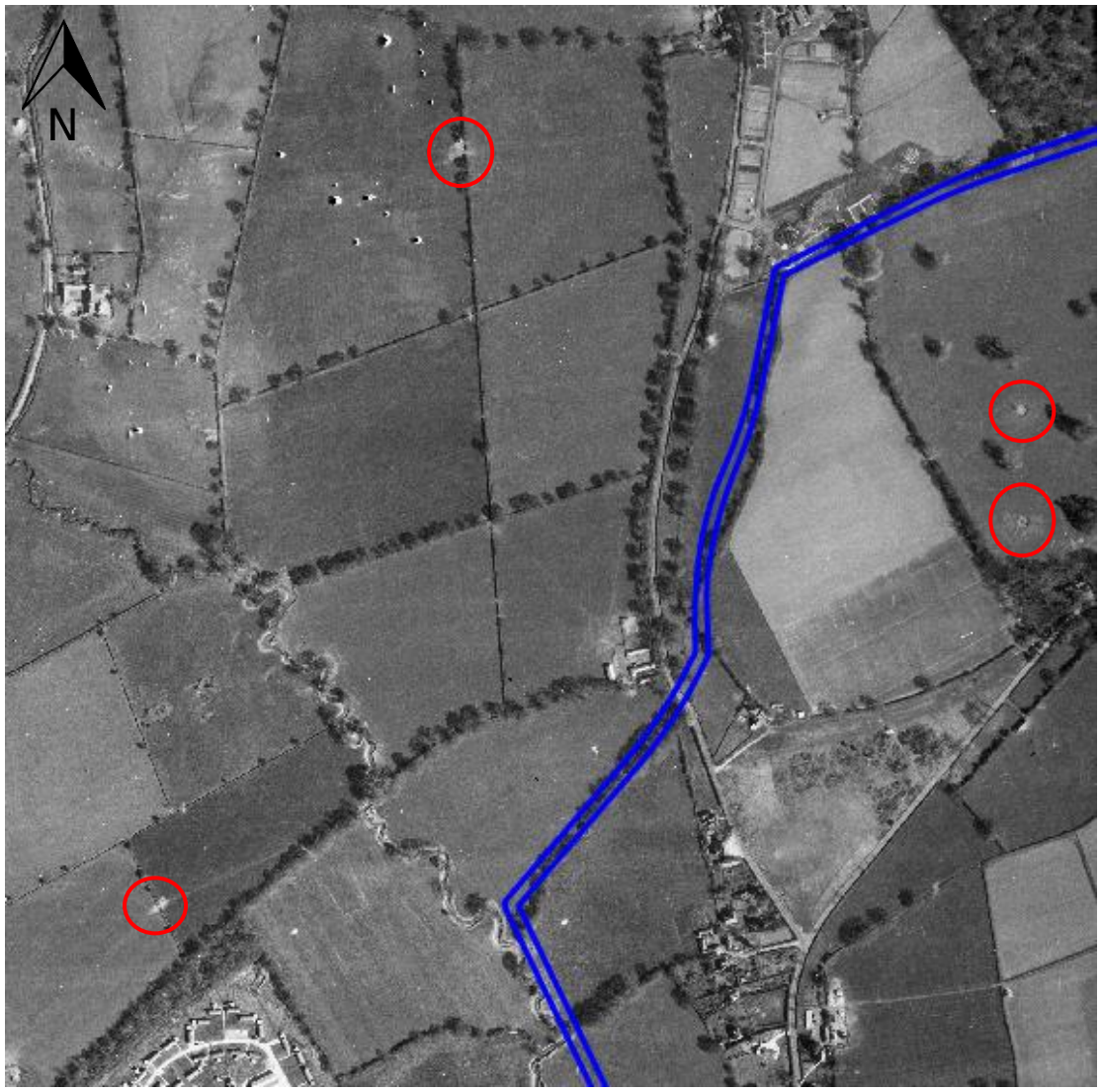
Plate 4 Aerial photograph of the northern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

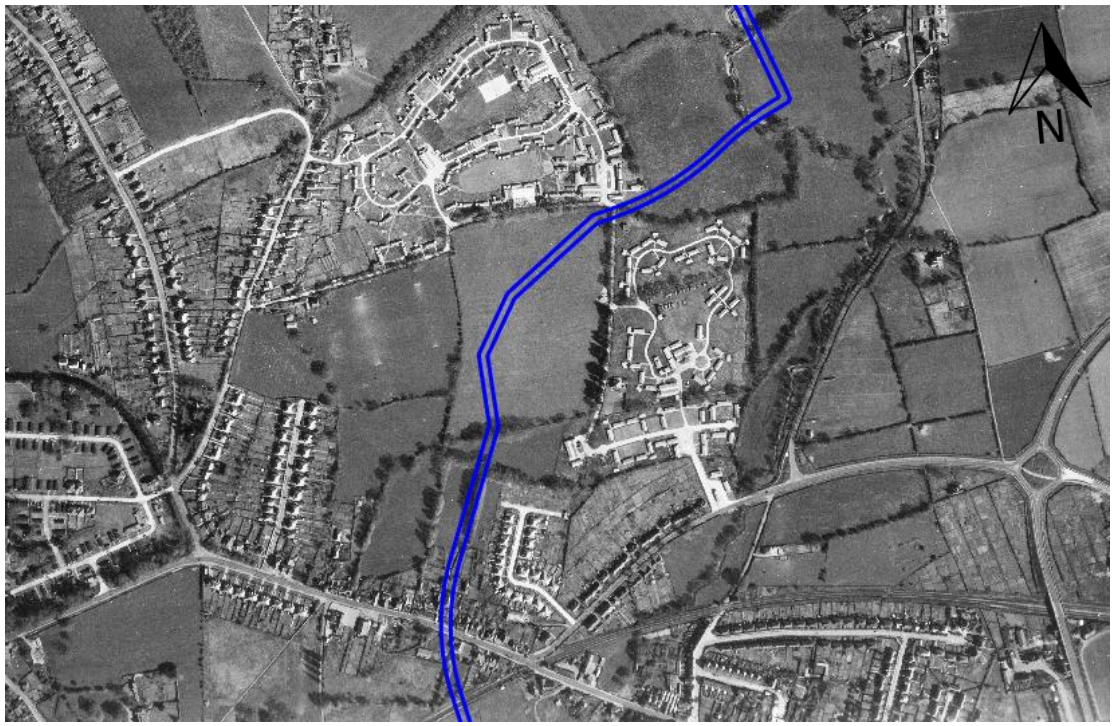
Plate 5 Aerial photograph of the central part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb damage

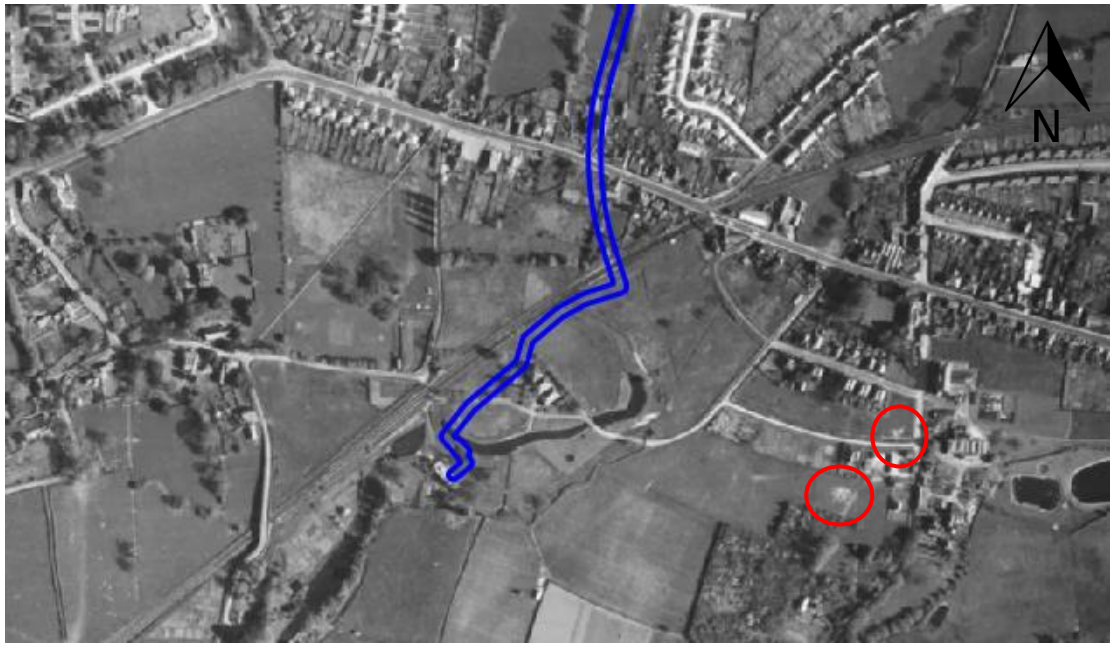
Plate 6 Aerial photograph of the central part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 7 Aerial photograph of the southern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb damage

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground and Made Ground, over clay, sand, and gravel, overlying the London Clay Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 1m of topsoil (modelled as soft clay), over 3.5m of sand and gravel, overlying more than 20m of stiff to firm clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.0m
	250kg	4.0m
	500kg	9.0m

Where Made Ground was present, the estimates average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds the following records of post-WWII EOC tasks having taken place in the vicinity of the Site.

1980 – 1981

Several items including 2No. 2" mortar HE bombs, 2No. 2" mortar smoke bombs, and 4No. no. 36 grenades, were found during a Bomb Disposal Squad (BDU) search at The Queen's Inclosure, approximately 2km west of the Site. These were removed.

26th April 2014

1No. grenade was discovered at Havant Depot, Penner Road, approximately 1.1km southeast of the Site. This was removed and destroyed.

16th April 2019

1No. 81mm shell was discovered at Havant Waste Recycling Centre, approximately 0.4km south of the Site. This was removed and destroyed.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

During WWII, troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the northern part of the Site. No records have been found indicate live munitions were used, although the possibility cannot be totally discounted.

In 1944, Havant Thicket was used as an assembly point for troops, equipment, vehicles, and tanks, as preparation for the 'D-Day' landings in occupied France.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the northern part of the Site, whilst unlikely, cannot be entirely discounted.

Military activity on Havant Thicket is not considered to provide a significant source of UXO hazard to the Site.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 6.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-R1-MAP01-A.

It should be noted that the potential to encounter UXO anywhere across a former marshalling area assembly point cannot be discounted. If UXO is found, a re-assessment of the hazard level is required.

Figure 6 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low	Moderate	
	High		Very High		

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: An UXO awareness briefing is recommended for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they can take appropriate action in the event of a suspect find.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is recommended that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

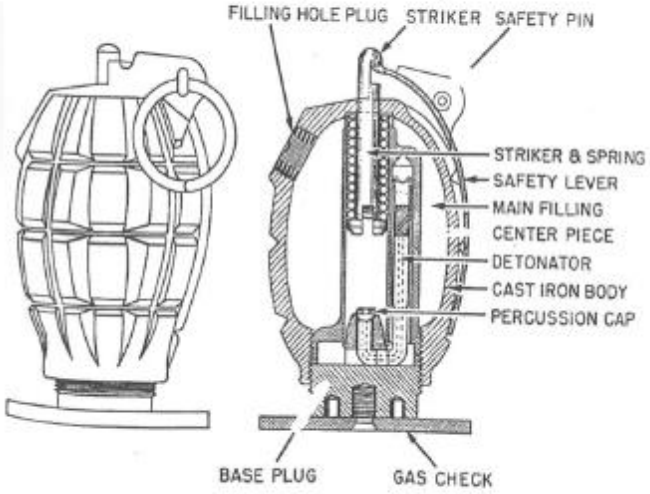
SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.





Information Data Sheet

Category Grenades (British)
Type No. 36 Hand Grenade ('Mills Bomb')



Variants	-	**Dimensions**	101.6mm x 61mm (4" x 2.4")
Weight	2 lbs	**Delay**	4 seconds
Filling	Baratol	**Material**	Cast Iron

Description Lemon-shaped, cast-iron body filled with high explosive. Three holes in the body; one in the base for priming, one near the top for filling; one on the top holding striker.

Function Used as a defence against enemy personnel.

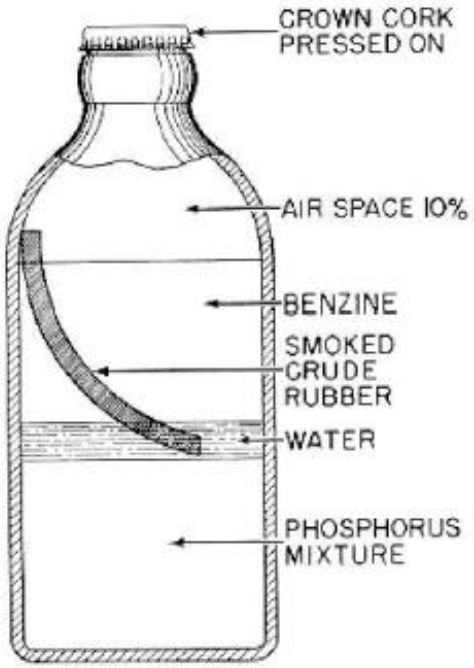




Information Data Sheet

Category Grenades (British)
Type No. 76 Self-Igniting Phosphorus Grenade

Variants	-
Dimensions	152.4mm x 63.5mm (6" x 2.5")
Weight	1lb
Fuze	Self-igniting upon breakage
Material	Glass
Description	Glass bottle filled with white phosphorus, benzene, water and crude rubber.
Function	Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.



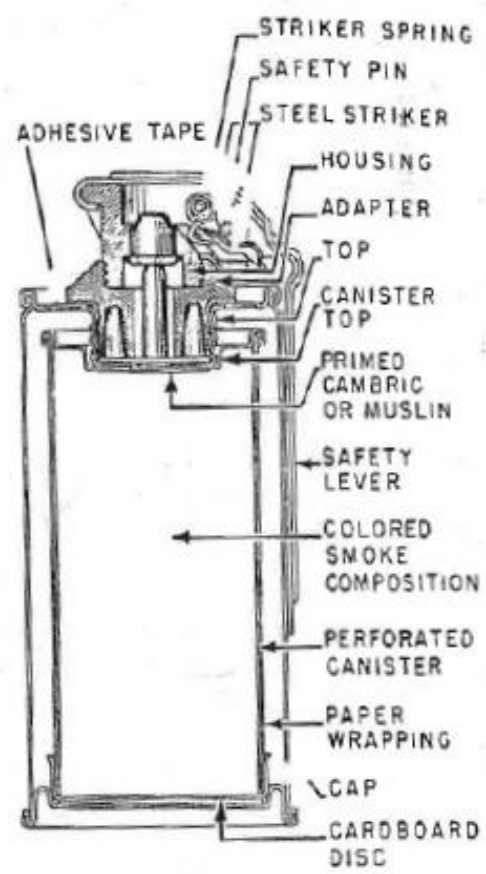




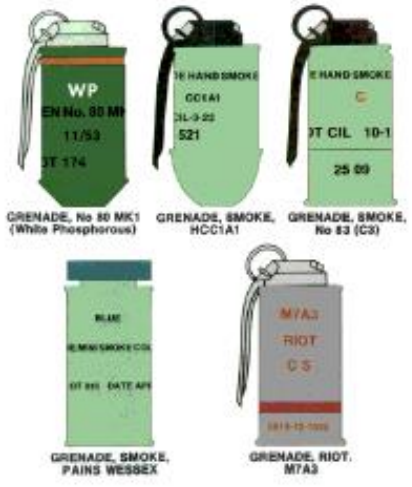
Information Data Sheet

Category Grenades (British)
Type Smoke Hand Grenade

Variants	Numerous
Body Dimensions	66mm x 114.3mm (2.6" x 4.5")
Weight	2lbs
Delay	4 seconds
Filling	Smoke (various colours)
Composition	Tin plate
Description	Green, cylindrical in shape with a perforated canister for emitting smoke.
Function	Used as signalling devices and for training purposes.

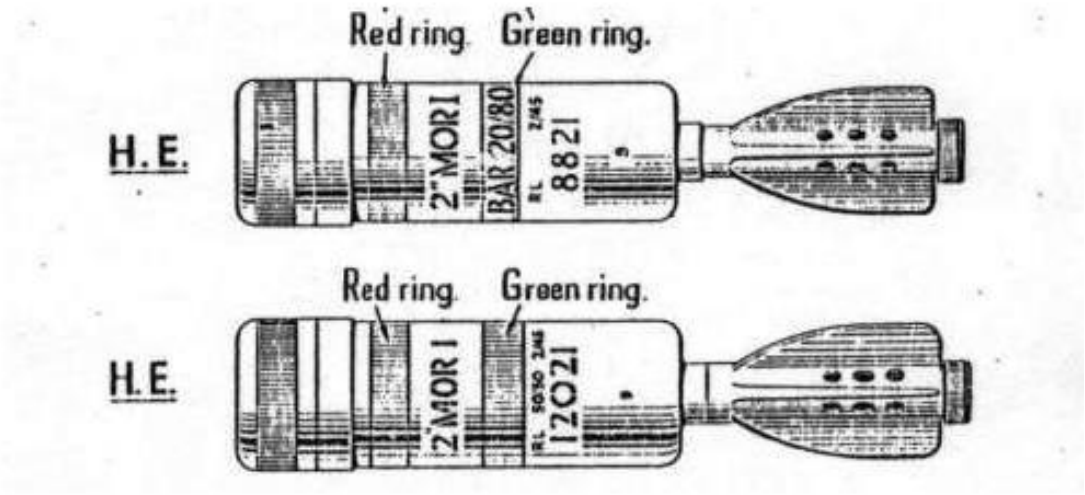






Information Data Sheet

Category Mortar (British)
Type 2-Inch Mortar Bomb



Variants	14	**Length**	11.4" x 2"
Weight	2.5lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	50.8mm (2.0 inches)	**Rate of Fire**	8 rounds per minute

Description Pear-shaped steel body with 6 or 8 vanes. Originally painted buff yellow or dark grey. Filled with c TNT, granular TNT or powdered Amatol. Also smoke, illumination and practice versions.

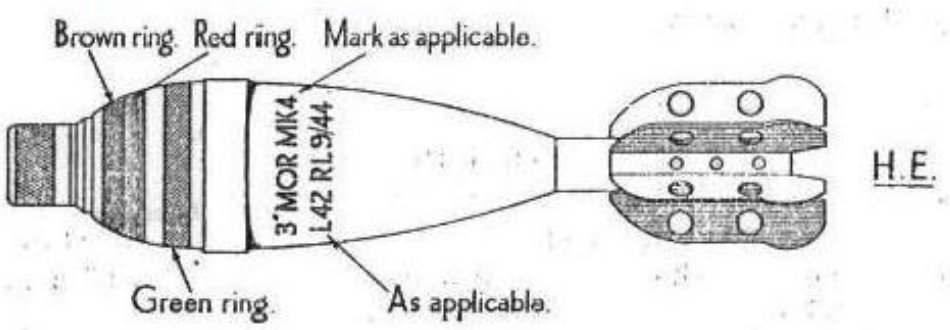
Function Small enough to be carried by one man, with a range limited to 500 yards, the 2" mortar was usec an anti-personnel role.





Information Data Sheet

Category Mortar (British)
Type 3-Inch Mortar Bomb



Variants	2	**Dimensions**	19.3" x 3"
Weight	10lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	76.2mm (3.0 inches)	**Rate of Fire**	12 rounds per minute

Description Pear-shaped steel body with vaned tail fin for stability in flight. Typically filled with high explosive or white phosphorus, the latter dispersing on detonation.

Function Range of up to 1,600 yards, the 3" mortar was used in an anti-personnel role.

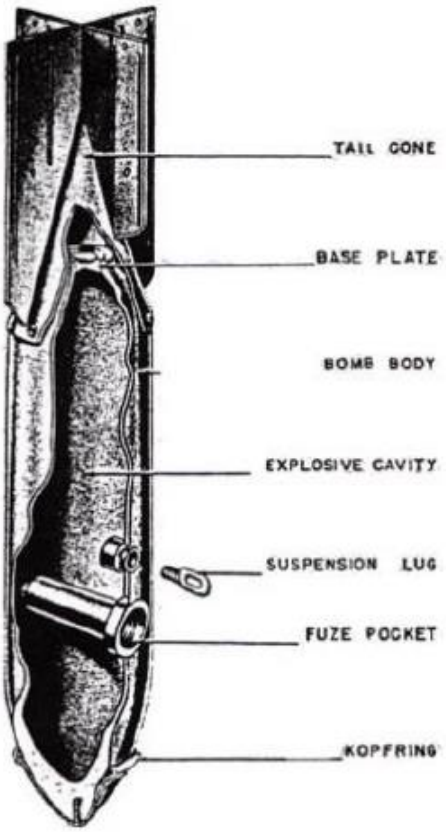




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



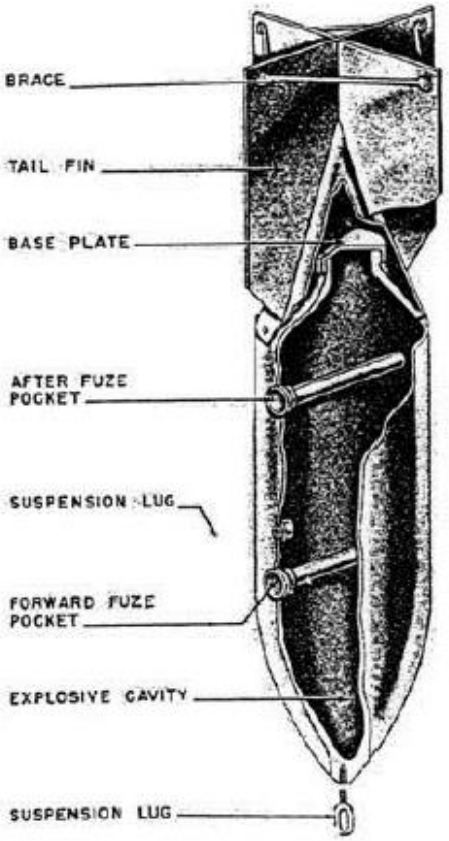




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



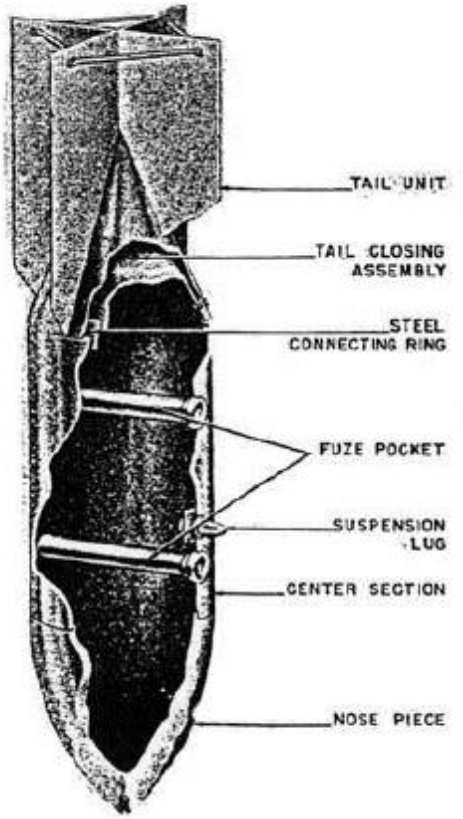




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



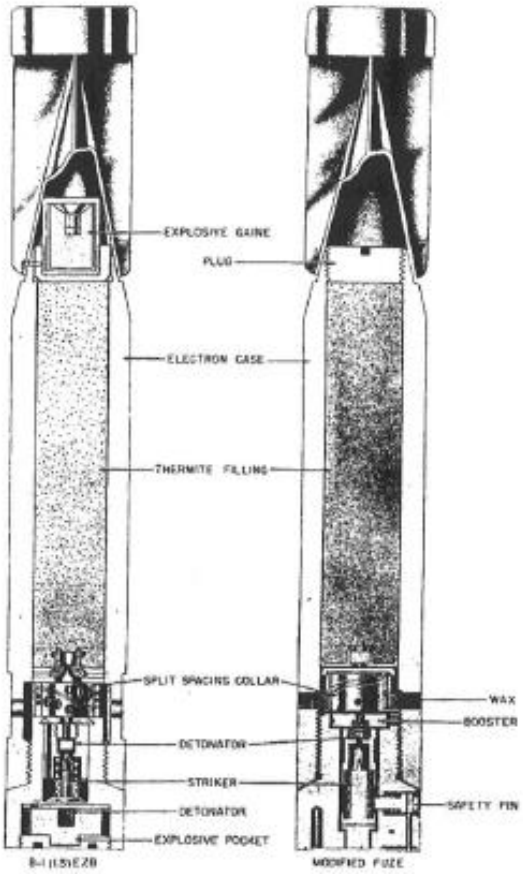




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 1kg

Variants	6
Body Dimensions	350mm x 50mm (13.8" x 1.97")
Weight	1kg & 1.3kg (2.2lbs & 2.86lbs)
Charge Weight	8 -15 gm (0.28 – 0.53 oz) in models with Nitropenta explosive. No charge in B-1 & B-1.3 E types.
Fuze	Impact fuze with safety plug
Composition	Sheet steel
Description	The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze. The after body is tapered to receive the sheet metal, three-fined drum-shrouded tail assembly. The bomb is unpainted magnesium; the tail is dark green.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations.



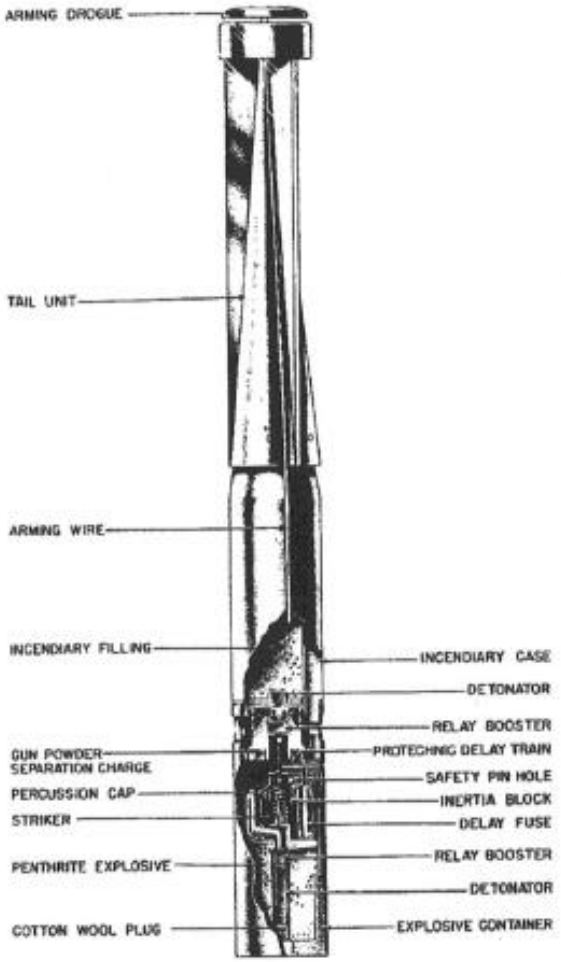




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 2kg

Variants	2
Body Dimensions	525mm x 50mm (20.67" x 1.97")
Weight	2kg & 2.2kg (4.4lbs & 4.85lbs)
Charge Weight	60g (0.13lbs)
Fuze	Impact fuze with screw impact
Composition	Sheet steel
Description	Steel cylinder. Body originally painted green with black explosive section and grey tail.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations. When dropped from 2000m could penetrate iron-concrete roofing.

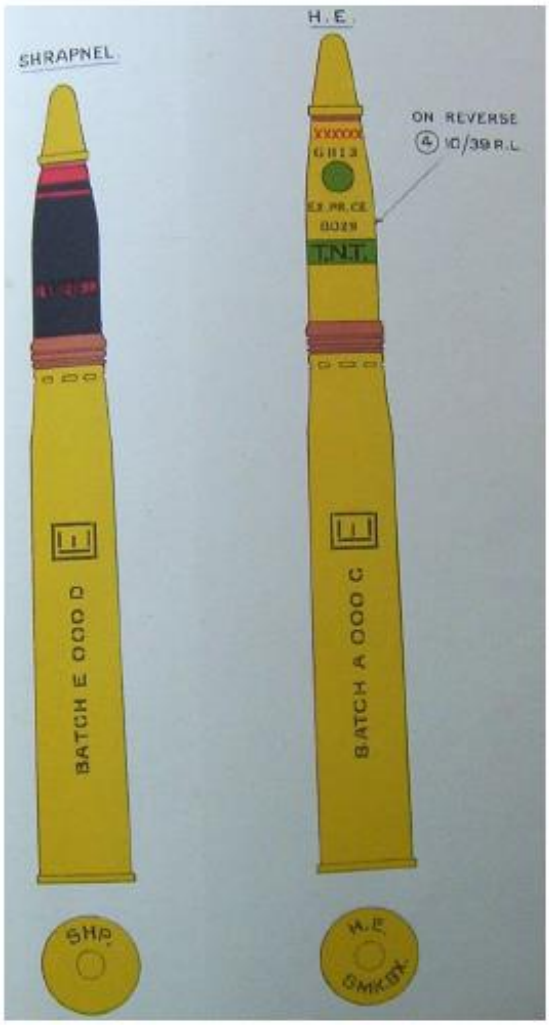






Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell



Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.





Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

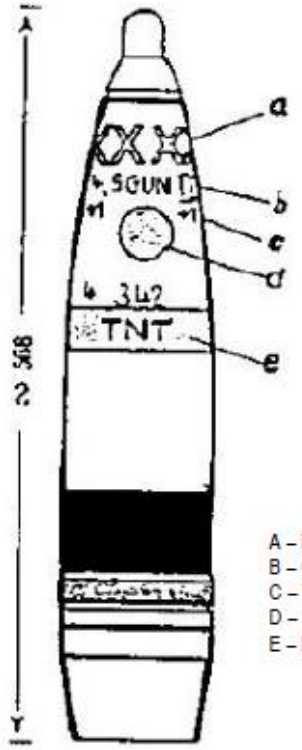
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 Military training areas

Information Data Sheet

Category Military Training Areas

Description:

In September 1939, approximately 235,000 acres of land was occupied by the Army for all purposes, including training. By February 1944, this had risen to 9,800,000 acres for training alone. This land was required for infantry and tank training, for beach assault, and for weapon practice. Where the land was selected, the civilian population was often required to leave and associated accommodations camps for the incoming troops had to be built.

Official training areas tend to have clearly delineated boundaries within which training is to take place. During World War Two (WWII) many areas of open fields and woodland were requisitioned under Defence Regulation 52 by military units stationed in the area. Training in these areas was often not subject to any official rules and regulations, or detailed record keeping.

Some training areas had associated firing ranges whilst others had provisions for armoured vehicle and tank training. Training areas also required firing points, stop butts, and observation and range control bunkers.

In the build-up to D-Day, marshalling areas for British and American troops were established near to the coast, and these areas were commonly used for training exercises using live munitions.



Testing flamethrowers at a WWII Battle Training Area

Hazard:

The types of Unexploded Ordnance (UXO) that could be present at former military training areas varies depending on their operational history. Ordnance used during exercises ranged from Small Arms Ammunition (SAA) to grenades, defensive mines, mortars and shells, and unconventional weapons such as flamethrowers.

'Dry' training areas will have primarily used blank ammunition, although even these areas are likely to have used live munitions at some stage.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

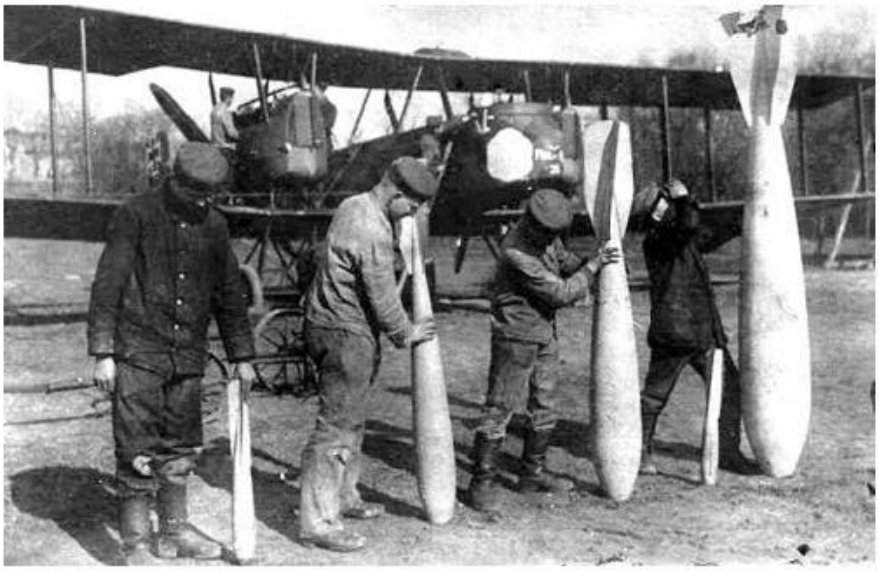
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.3 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.4 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 [redacted] incident list

9th September 1940

1No. HE bomb fell on Manor House, Bedhampton, approximately 0.3km west of the Site. This was recorded as an UXB.

11th September 1940

1No. HE bomb fell on High Lawn, Leigh Park, approximately 0.2km east of the Site.

29th September 1940

24No. IBs fell on Leigh Park, approximately 60m east of the Site.

30th September 1940

5No. IBs fell on the pasture fields of Smith's Farm, adjacent to the Site.

29th October 1940

10No. HE bomb fell on the grounds of Leigh Park Farm, approximately 0.3km east of the Site. 1No. of these was recorded as an UXB.

16th January 1941

1No. HE bomb fell on a field near Park Lane, approximately 0.3km west of the Site.

17th January 1941

2No. HE bombs fell on fields near Stockheath Farm, approximately 0.2km east of the Site.

11th April 1941

4No. HE bombs fell on Havant Thicket, approximately 0.3km northeast of the Site.

14th June 1941

1No. HE bomb fell on High Lawn, near Leigh Park House, approximately 0.3km east of the Site. This was recorded as an UXB.

21st August 1942

4No. HE bombs fell on Ranelagh Road, approximately 0.2km east of the Site.

8th March 1943

1No. Oil Bomb (OB) fell on Portsdown Hill, approximately 0.5km west of the Site.

Several IBs fell on Middle Park Farm, approximately 0.5km west of the Site.

16th August 1943

2No. HE bombs fell on Havant Thicket, approximately 0.2km north of the Site.

1No. OB and several IBs fell on open ground near Brockhampton Road water works, approximately 0.5km southeast of the Site.

24th February 1944

1No. IB fell on Bell's Copse, approximately 0.4km west of the Site. This was recorded as an UXIB.

Appendix 6 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Graves C, The Home Guard of Britain, 1943

Hind R W, The Naval Camps of Bedhampton and Leigh Park, 2017

Jeffery D, Petersfield at War, 2004

Leete J, In Time of War Hampshire, 2007

Marsham P, Rowlands Castle in World War Two, 1994

Morris J, German Air Raids on Britain 1914-1918, 1993

Pile J, Belmont Park, Bedhampton the Estate, The House and its People, 2012

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 7 General Notes

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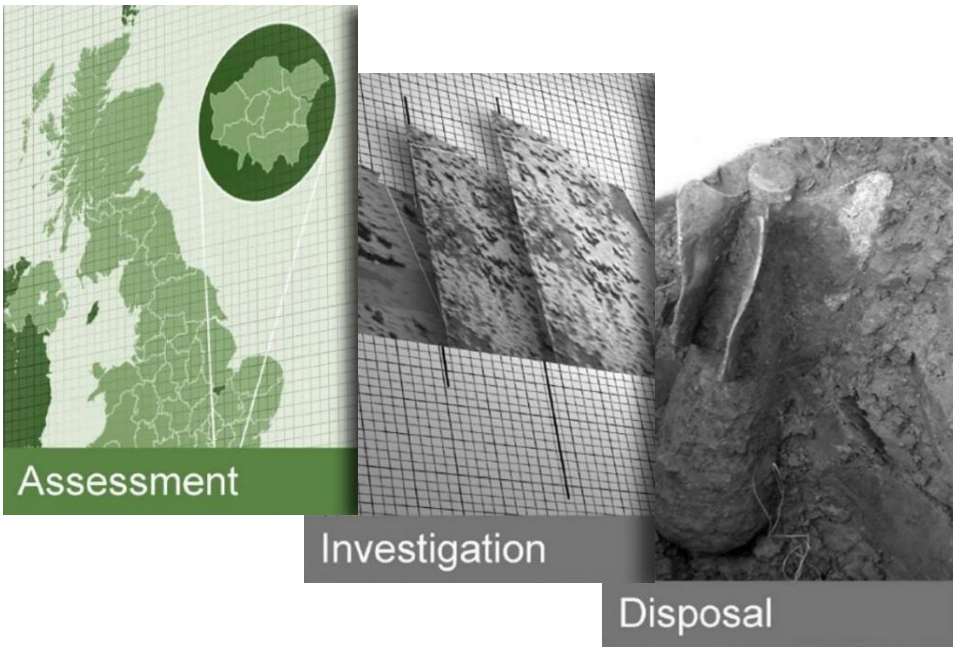
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R2**
Revision	**A**
Project Title	**Hampton Thicket Reservoir**
Client	**Southern Water**
Date	**5th April 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: An UXO awareness briefing is recommended for staff involved in excavations.

UXO hazard assessment

During World War Two (WWII), troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the Site. No records have been found indicate live munitions were used, although the possibility cannot be totally discounted.

In 1944, Havant Thicket was used as an assembly point for troops, equipment, vehicles, and tanks, as preparation for the 'D-Day' landings in occupied France.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the Site, whilst unlikely, cannot be entirely discounted.

Military activity on Havant Thicket is not considered to provide a significant source of UXO hazard to the Site.

Records have been found indicating that 13No. High Explosive (HE) bombs fell on the Site during WWII. 1No. of these was recorded as an Unexploded Bomb (UXB) and removed. This is considered representative of a low localised bombing density given the size of the Site.

No further bombing records and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R2-MAP01-A.

It should be noted that the potential to encounter UXO anywhere across a marshalling area assembly point cannot be discounted. If UXO is found a re-assessment of the hazard level is required.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- In August 1940, Leigh Park House, adjacent to the southern part of the Site, was requisitioned by the Royal Navy (RN) to be used by the Admiralty Mine Design Department (MDD).
- During WWII, troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the Site.
- By 1941, Stockheath Naval Camp was established on land adjacent to the southern part of the Site. This was designated as an accommodation camp.
- During 1944, Havant Thicket, on the Site, was used as an assembly point as part of preparations for the 'D-Day' landings in occupied France. Several military units and equipment, tanks, and military vehicles were present at Havant Thicket.
- After WWII, the MDD remained at Leigh Park House, continuing to design mines and depth charges. In 1956, the Admiralty left Leigh Park House, which was demolished in March 1959.
- By the 1950s Stockheath Camp was demolished for the development of residential buildings.

- During WWII the main strategic targets in the vicinity of the Site included military camps and barracks, and Portsmouth Water Company.
- Records have been found indicating 13No. HE bombs fell on the Site during WWII. 1No. of these was recorded as an UXB and removed. No further records of bombing on the Site have been found.
- There were 12No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

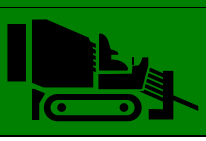
Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	**Low**
	HDD	1	1	1	1	4	4	**Low**
Other UXO	Excavations	1	1	1	1	4	4	**Low**
	HDD	1	1	1	1	3	3	**Low**
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

Risk mitigation plan

Further details on the recommended risk mitigation techniques are given in Section 8.2 of this report.

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they can take appropriate action in the event of a suspect find.

What do I do next?

If you require a quote for an awareness briefing or further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS data

P14032-24-R2-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AME	Admiralty Mining Establishment
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BDU	Bomb Disposal Unit
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FAA	Fleet Air Arm
HAA	Heavy Anti-Aircraft
HE	High Explosive
HER	Historic Environment Record
HMS	His Majesty's Ship
HQ	Headquarters
IB	Incendiary Bomb
IWM	Imperial War Museum
KBB	Kite Balloon Base
LAA	Light Anti-Aircraft
MDD	Mine Design Department
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RA	Royal Artillery
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RE	Royal Engineers
RM	Royal Marines
RN	Royal Navy
UCWE	Underwater Countermeasures and Weapons Establishment
UK	United Kingdom
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an area of approximately 295 hectares (ha) off Manor Lodge Road in Havant, Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Archives and Local Studies, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

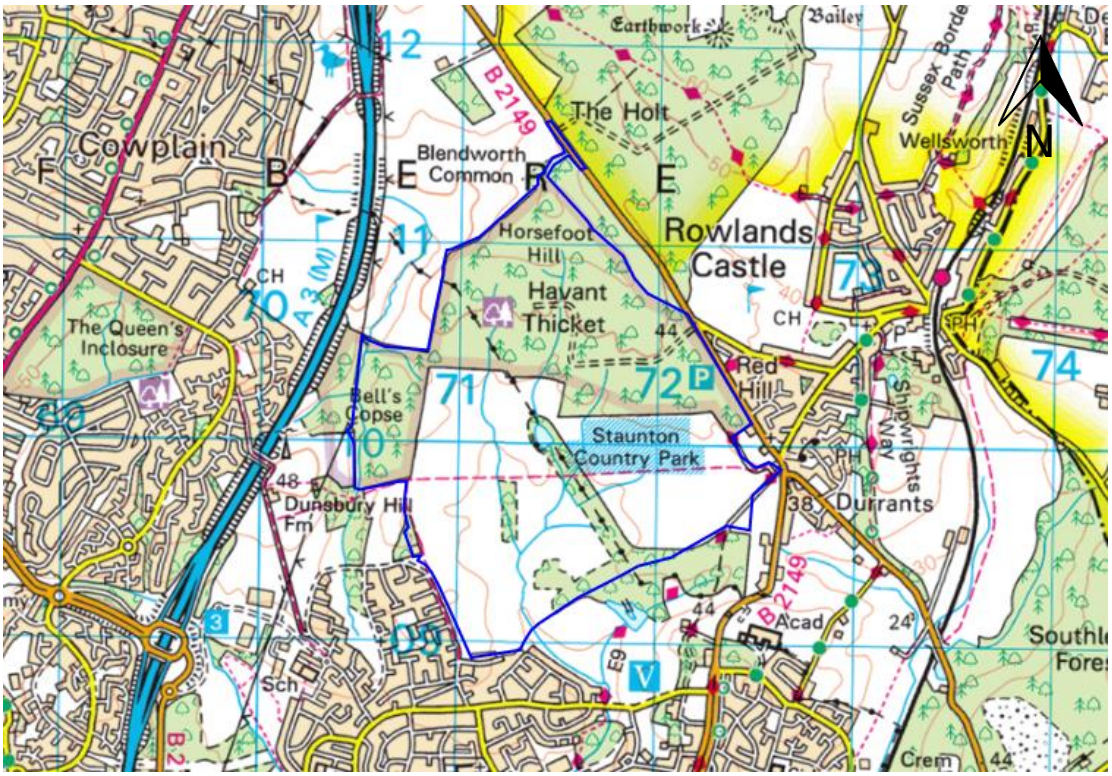
2.1 Site location

The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU715102. It is located approximately 9.1km northeast of central Portsmouth.

The Site comprises open ground, woodland, and is crossed by the B2149. It is bounded to the north by open ground, woodland, and the B2149, to the east by Manor Lodge Road and residential buildings, to the south and west by open ground, woodland, and residential buildings.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Military camps and marshalling areas

Several military camps and marshalling areas have been identified in the vicinity of the Site. Details are provided below.

3.1.1 Marshalling Area 'A'

In 1944, during preparations for the D-Day invasions of Normandy, a series of Marshalling Areas were established throughout southern England. The War Office (WO) requisitioned land and property, and restricted civilian travel within marshalling areas.

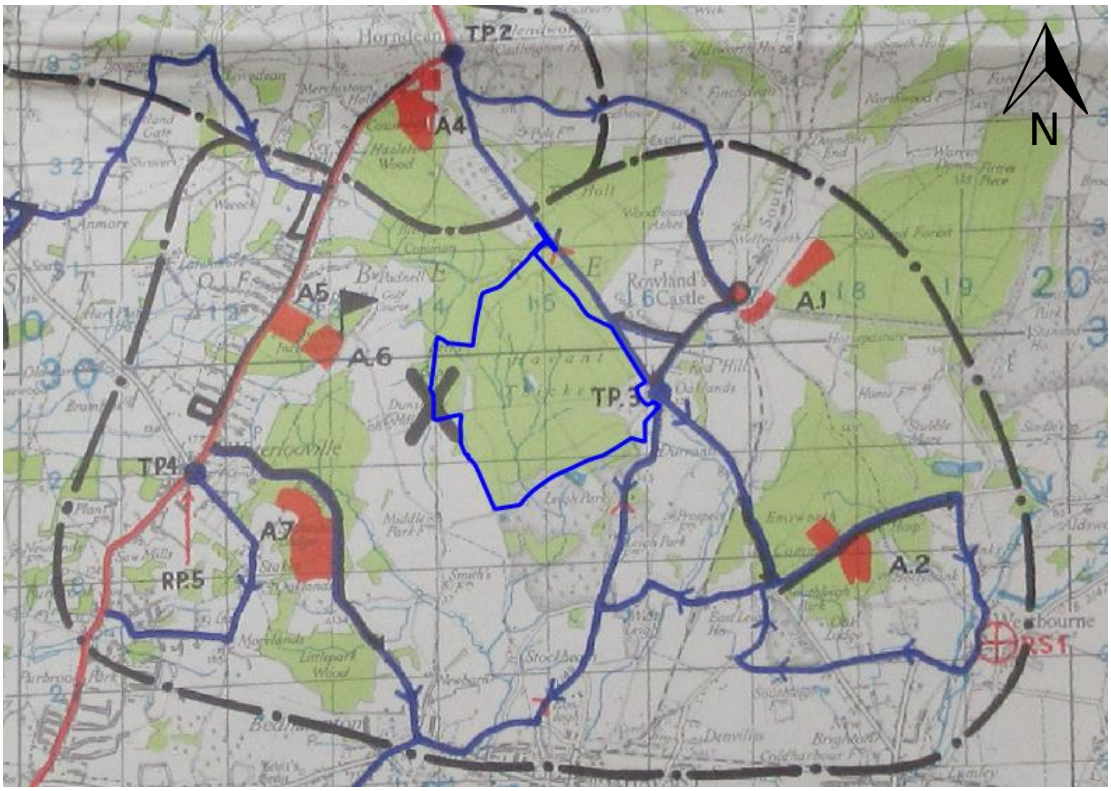
Marshalling areas were typically split into sub-areas, containing embarkation points, military camps, vehicle parks, and stores depots to accommodate the build-up of troops and material prior to D-Day.

The Site was encompassed by Marshalling Area 'A'. Sub-area 'X', within Marshalling Area 'A', included areas of Havant, Bedhampton, and Leigh Park, in the vicinity of the Site.

Figure 2 is a plan dated the 18th April 1944 showing the extents of Sub-area 'X', encompassing the Site. It also shows troop camps ('A1' – 'A7'), traffic posts (T.P.2 – T.P.4), and roadways allocated to military transport.

No records of camps on or in the vicinity of the Site have been found. The nearest camp was 'A6', Cowplain, approximately 0.9km west of the Site. Camp 'A6' accommodated 1,500No. men and 215No. vehicles from the 2nd Battalion, East Yorkshire Regiment.

Figure 2 Plan of Marshalling Sub-area 'X', 18th April 1944



Source: The National Archives *Not to Scale*

Legend	Site boundary	Troop camps	Sub-area boundary
	Sub-area HQ	One way route	Two-way route

During 1944, Havant Thicket, on the Site, was used as an assembly point. Records indicate several military units and equipment, tanks, and military vehicles were present at Havant Thicket.

Ad hoc military training is known to have occurred in D-Day Marshalling Areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on historical aerial photography (see Plates 3 - 5).

After WWII, requisitioned land and property was returned to its original ownership and use.

In June 2023, metal detectorists conducted a search of Havant Thicket, on the Site. Remnants from military activities were found, although no further details were provided on what these items were, it is considered unlikely these items were UXO.

Potential UXO hazard

In 1944 Havant Thicket was used as an assembly point for troops, equipment, and vehicles as preparation for the invasion of Normandy.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the Site, whilst unlikely, cannot be entirely discounted.

It is considered that any munitions that may have been present at Havant Thicket are likely to have been removed during subsequent tree felling activities in Havant Thicket post-WWII.

Marshalling Area 'A' is not considered to provide a significant source of UXO hazard to the Site.

3.1.2 Stockheath Naval Camp

In 1941, Stockheath Naval Camp was established on land near Riders Lane, adjacent to the southern part of the Site.

Stockheath Naval Camp was initially used as a Royal Naval (RN) overflow camp for Portsmouth Naval Barracks, approximately 10.4km southwest of the Site. Throughout WWII, the camp was also used as a RN survivors recuperation camp.

The camp covered an area of 200ha and comprised of several Nissen nuts and an assault course, approximately 0.5km south of the Site (see Plate 2).

Stockheath Naval Camp also accommodated a detachment of Royal Marines (RMs). Records indicate the RMs would carry out training exercises in the surrounding fields, in the immediate vicinity of the Site.

The camp was also used to provide a 'flying column' in the event of invasion. The flying column was an ad-hoc unit of 100No. men that could be rapidly mobilised.

In March 1942, the flying column took part anti-invasion training exercise at the camp, in the vicinity of the Site, with the army and local Home Guard units (see Section 3.3.2). Troops involved in the training exercise were issued with rifles and live ammunition. This would likely have comprised Small Arms Ammunition (SAA).

Plate 2 is an aerial photograph dated the 19th April 1946. The extents of Stockheath Camp, 1No. practice trench, Nissen huts, and the assault course have been identified.

Leigh Park House has also been identified (see Section 3.1.3).

Plate 2 Aerial photograph, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Stockheath Camp	Assault course
	Leigh Park House	Nissen huts	Practice trench

After WWII, Stockheath Camp was abandoned and was demolished. During the 1950s a section of the camp was redeveloped into a residential estate.

In the 1960s, the remainder of the former camp was purchased and redeveloped into Great Copse estate.

Stockheath Naval Camp is not considered to provide a significant source of UXO hazard to the Site.

3.1.3 Leigh Park House

On the 30th August 1940 Leigh Park House, adjacent to the southern part of the Site, was requisitioned by the Admiralty Mine Design Department (MDD) (see Plate 2).

Previously stationed at His Majesty's Ship (HMS) Vernon, approximately 9.7km southwest of the Site, Leigh Park House became the Headquarters (HQ) and administrative centre for MDD sections responsible for the design of mines, depth changes and minesweeping.

An MDD research section was also established at West Leigh House, approximately 1.5km south of the Site. Naval staff responsible for the trials of MDD equipment were accommodated at West Leigh Cottage, approximately 1.4km south-southeast of the Site.

Leigh Park House was equipped with several Nissen huts, and various buildings of the house were repurposed. The icehouse, approximately 0.1km south of the Site, which repurposed as a magazine to store explosives.

The grounds of the house, in the vicinity of the Site, were used for various test, with magnetic mines tests in a magnetic hut. The Lake at Leigh Park, approximately 45m south of the Site, was used for under-water experiments.

Leigh Park House also had its own Home Guard based in Leigh Park, adjacent to the southern part Site (see Section 3.3.2). Records indicate the Home Guard conducted manoeuvres on park and the surrounding woodland of Leigh Park.

After WWII, the Admiralty remained at Leigh Park House, with the grounds of Leigh Park being sold to Portsmouth City Council. In 1946, HMS Vernon's MDD was reconstituted at Leigh Park House as the Admiralty Mining Establishment (AME).

In 1951, the AME was renamed the Underwater Countermeasures and Weapon Establishment (UCWE), focusing on the design of anti-submarine weapons and sensors.

In 1957, the Admiralty vacated Leigh Park House, which was demolished in 1959.

Leigh Park House is not considered to provide a source of UXO hazard to the Site.

3.2 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

Other than those detailed in Section 3.1, no records of any firing ranges or military training areas on the Site have been found. The nearest is detailed below.

3.2.1 Stansted Park

On the 13th April 1942, a Canadian Battle Training School was established at Stansted Park, approximately 1.2km east of the Site.

The school provided troops with Battle Drill Training, comprising physical training, fieldcraft, and battle inoculation, which involved realistic training in a simulated battle scenario using live ammunition.

Lectures, demonstrations, and practice sessions took place within the grounds of Stansted Park. The school's training also took place at several other locations including beach landings at Hayling Island, approximately 9.1km south of the Site, and battle inoculation at Gravel Hill, approximately 6.1km north of the Site.

Records indicate that troops stationed at Stansted Park undertook stealth training exercises, including 'stalking', training at Havant Thicket. No records have been found to indicate live munitions were used during the exercises.

In September 1942, the school at Stansted Park was closed and moved to Windlesham House, approximately 39km east of the Site.

In 1944, Stansted Park was repurposed as camp 'A1' as part of preparations for the 'D-Day' landings in occupied France (see Section 3.1.1).

Potential UXO Hazard

No evidence has been found indicating that troops stationed at Stansted Park used live munitions during stealth exercises on Havant Thicket, although this cannot be totally discounted.

Stansted Park military training is not considered to provide a significant source of UXO hazard to the Site.

3.3 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.3.1 Anti-Aircraft (AA) guns

During WWI there were 8No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Purbrook (SU 678064), approximately 4km southwest of the Site. It was armed with 1No. 18-pounder (pdr) gun.

During WWII there were 12No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Prospect Farm (SU 728091), approximately 0.5km southeast of the Site. Its armaments are unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

10th March 1941

1No. AA shell fell on Petersfield Road, approximately 0.4km south-southeast of the Site. This was recorded as an Unexploded AA (UXAA) shell.

24th February 1945

1No. AA sell fell on open ground, near Whichers Gate Road, approximately 0.3km east-northeast of the Site. This was recorded as an UXAA shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.3.2 Home Guard

During WWII, the 16th (Havant) Hampshire Home Guard Battalion operated in the vicinity of the Site.

The Home Guard was responsible for patrolling local transport links and strategic targets, as well as manning regional anti-invasion defences.

During WWII Home Guard troops were involved in anti-invasion exercises at Stockheath Camp (see Section 3.1.2).

Leigh Park House, adjacent to the southern part of the Site, had its own Home Guard based at the park (see Section 3.1.3). The unit performed training manoeuvres on the park and the surrounding woodland of Leigh Park, on the Site.

No evidence has been found indicating the manoeuvres at Leigh Park involved live munitions, although the possibility cannot be totally discounted.

Potential UXO Hazard

It should be noted that records of Home Guard activities were rarely kept, and training activities were usually unofficial or unsanctioned.

Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often buried or dumped in ad-hoc locations.

Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

3.3.3 Bombing decoys

The nearest recorded bombing decoy was located at North Binness Island (SU 695046) approximately 4.6km southwest of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.4 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was No. 15 Kite Balloon Base (KBB) at Tipner, approximately 9km southwest of the Site. It operated maritime patrols between 1917 and August 1919.

After WWI, No. 15 KBB was closed.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Funtington, approximately 7.5km east-southeast of the Site. The airfield was established in September 1943 as an Advanced Landing Ground (ALG).

RAF Funtington was primarily occupied by fighter and bomber aircraft arriving from airfields further inland who would refuel and rearm before undertaking attacks on Europe.

By December 1944, RAF Funtington ceased operational flying, but facilities and stores remained in use until late 1946. The land was eventually returned to agriculture and partially integrated into a post-WWII radar facility.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.5 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on the Site have been found. The nearest is detailed below.

26th August 1940

1No. Heinkel 111P (2165) bomber aircraft, crashed on open ground near Westbrook Farm, Tempest Avenue, approximately 0.6km west of the Site.

Potential UXO Hazard

The above aircraft crash may have resulted in SAA from the aircraft guns being scattered across a wide area, potentially including the Sites.

SAA is not considered to provide a significant UXO hazard (see Appendix 1).

Aircraft crashes are not considered to provide a significant source of UXO hazard to the Sites.

3.6 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.3 or use the following link.

- [redacted]

Records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids on Hampshire began in the summer of 1940 and continued until the end of WWII. Over one third of the total number of bombs fell on Southampton, approximately 28.6km west of the Site, and Portsmouth, approximately 9.3km southwest of the Site.

Rural areas remained at risk of bombing. This often comprised 'tip and run' or opportunity attacks by small groups of aircraft. Other bombs were jettisoned by aircraft enroute to or returning from targets elsewhere in the UK.

From 1944, Hampshire was also at risk from the Pilotless Aircraft (V1) offensive. These weapons were highly inaccurate and often missed their intended targets by several km.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precautions (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including military camps and barracks, and Portsmouth Water Company.

The nearest identified Luftwaffe target was Portsmouth Water Company, approximately 3.9km southwest of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for V1s and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Petersfield RD	**457**	**9**	**19**	**485**	**8.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Havant & Waterloo UD	375	39	9	423	35.0
Chichester RD	1,154	38	29	1,221	11.9
Droxford RD	599	38	26	663	10.6
Petersfield UD	18	0	2	20	7.2
Midhurst RD	268	0	11	279	4.2

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further recorded bombing incidents in the vicinity of the Site.

29th September 1940

24No. IBs fell on Leigh Park, approximately 0.1km south-southeast of the Site.

10th March 1941

1No. High Explosive (HE) bomb fell on Rowlands Castle golf course, approximately 0.3km east of the Site.

11th March 1941

8No. HE bombs fell on open ground of Oaklands, approximately 0.2km northeast of the Site.

11th April 1941

4No. HE bombs fell on Havant Thicket, on the Site.

29th April 1941

1No. HE bomb fell on the northern part of Havant Thicket, on the Site.

17th April 1942

4No. HE bombs fell on Rowlands Castle golf course, approximately 0.3km east-northeast of the Site.

16th August 1943

2No. HE bombs fell on Havant Thicket, on the Site.

2No. HE bombs fell on the eastern part of Havant Thicket, approximately 80m northeast of the Site.

23rd August 1943

1No. HE bomb fell on Havant Thicket, on the Site. This was recorded as an UXB and removed on the 25th August 1943.

24th February 1944

1No. IB fell on Bell's Copse, on the Site. This was recorded as an Unexploded IB (UXIB) and removed on the 25th February 1944.

27th April 1944

5No. HE bombs fell on Havant Thicket, on the Site.

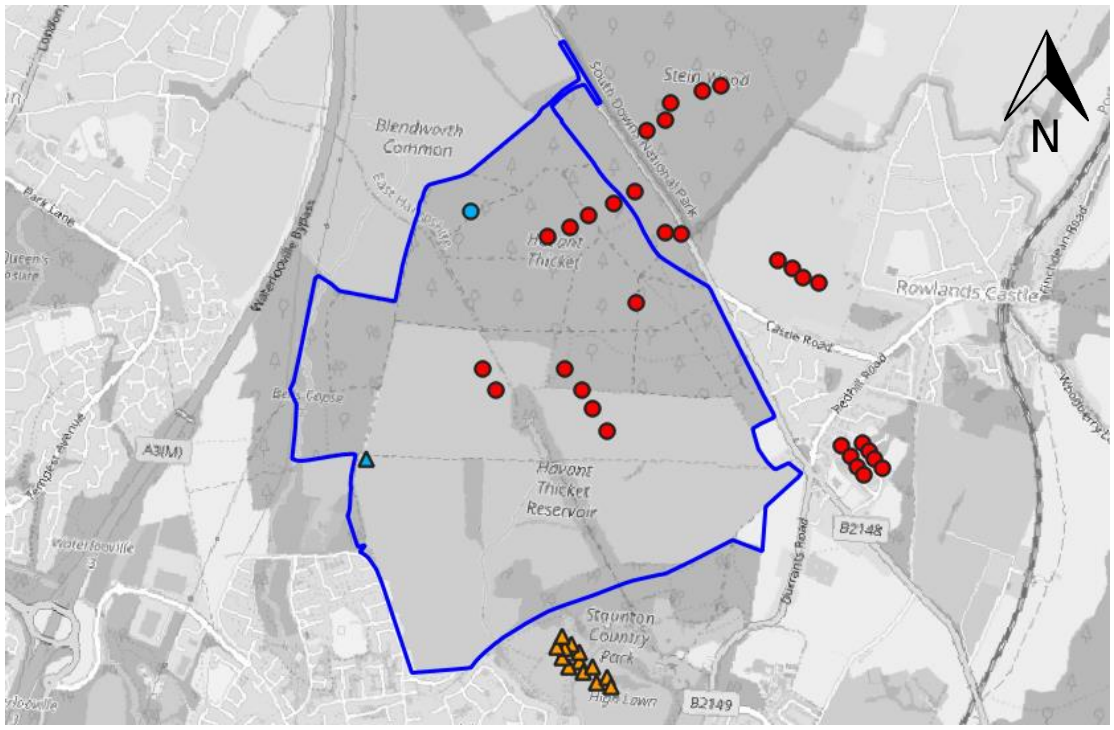
5No. HE bombs fell on The Holt, approximately 0.3km east of the Site.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R2-MAP01-A.

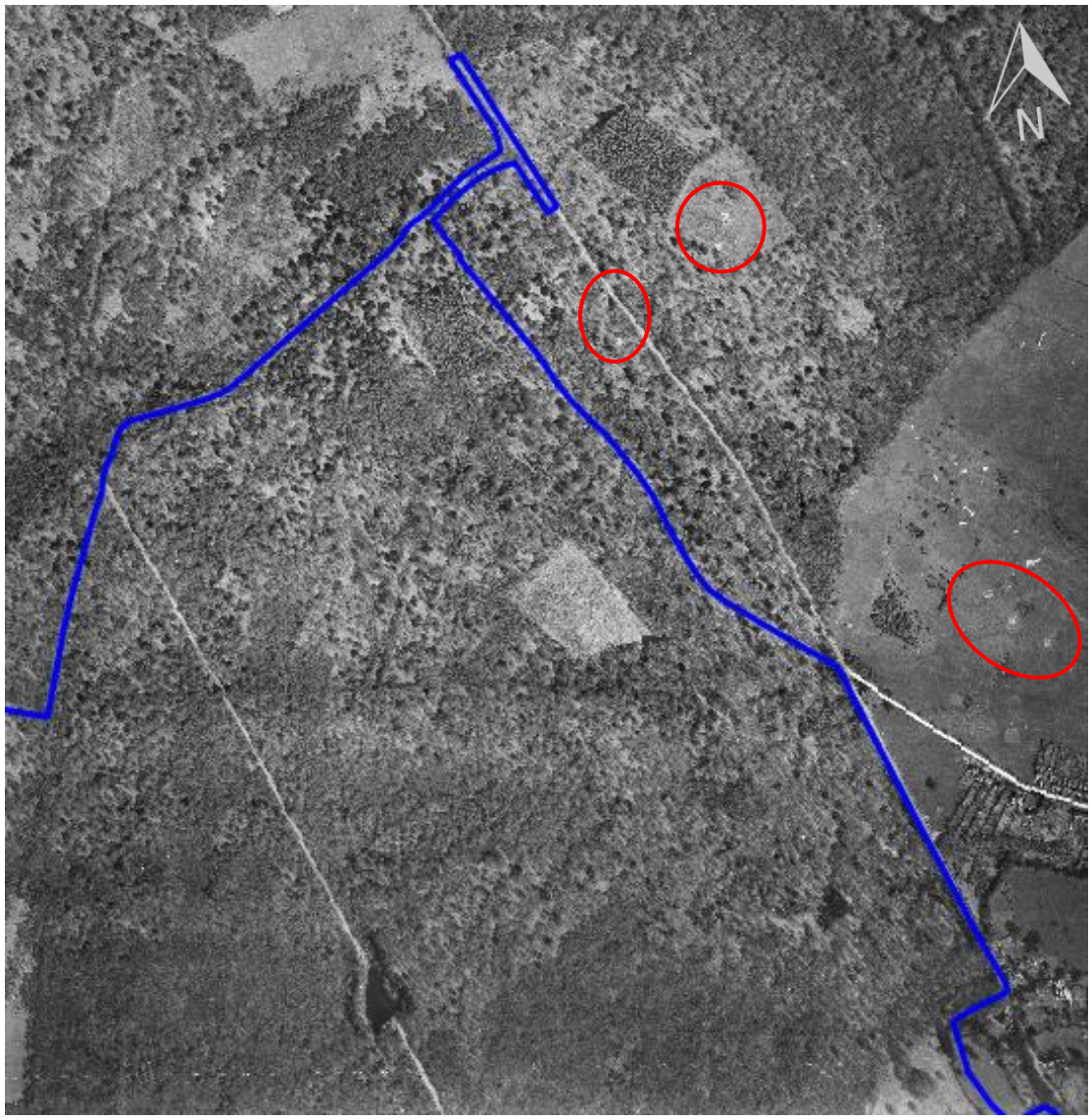
Figure 3 Compiled bomb impact map for the vicinity of the Site



Plates 3 – 5 are aerial photographs dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

Some possible cratering has been identified in the vicinity of the Site.

Plate 3 Aerial photograph of the northern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb damage

Plate 4 Aerial photograph of the southeastern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 5 Aerial photograph of the southwestern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

Records have been found indicating that 13No. HE bombs fell on the Site. 1No. of these was recorded as an UXB and removed. This is considered representative of a low localised bombing density given the size of the Site.

No further records of bombing on the Site have been found, and no bomb damage or cratering has been identified on the Site on historical aerial photography.

Bombing incidents in the area were the result of overspill from larger raids on central Portsmouth, over 9.2km southwest of the Site, with bombing densities dropping off in the immediate vicinity of the Site.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground, over clay, overlying the London Clay Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of topsoil (modelled as dry clay), over 4m of firm to stiff clay, overlying more than 20m of stiff to hard clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	5.0m
	250kg	6.0m
	500kg	9.0m

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds the following records of post-WWII EOC tasks having taken place in the vicinity of the Site.

1980 – 1981

Several items including 2No. 2" mortar HE bombs, 2No. 2" mortar smoke bombs, and 4No. no. 36 grenades, were found during a Bomb Disposal Squad (BDU) search at The Queen's Inclosure, approximately 0.9km west of the Site. These were removed.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

During WWII, troops stationed at Stansted Park undertook stealth exercises at Havant Thicket, on the Site. No records have been found indicate live munitions were used, although the possibility cannot be totally discounted.

In 1944, Havant Thicket was used as an assembly point for troops, equipment, vehicles, and tanks, as preparation for the 'D-Day' landings in occupied France.

Due to the concentration of military troops and equipment on Havant Thicket, the possibility of localised spillage and disposal of UXO on the Site, whilst unlikely, cannot be entirely discounted.

Military activity on Havant Thicket is not considered to provide a significant source of UXO hazard to the Site.

Records have been found indicating that 13No. HE bombs fell on the Site during WWII. 1No. of these was recorded as an UXB and removed. This is considered representative of a low localised bombing density given the size of the Site.

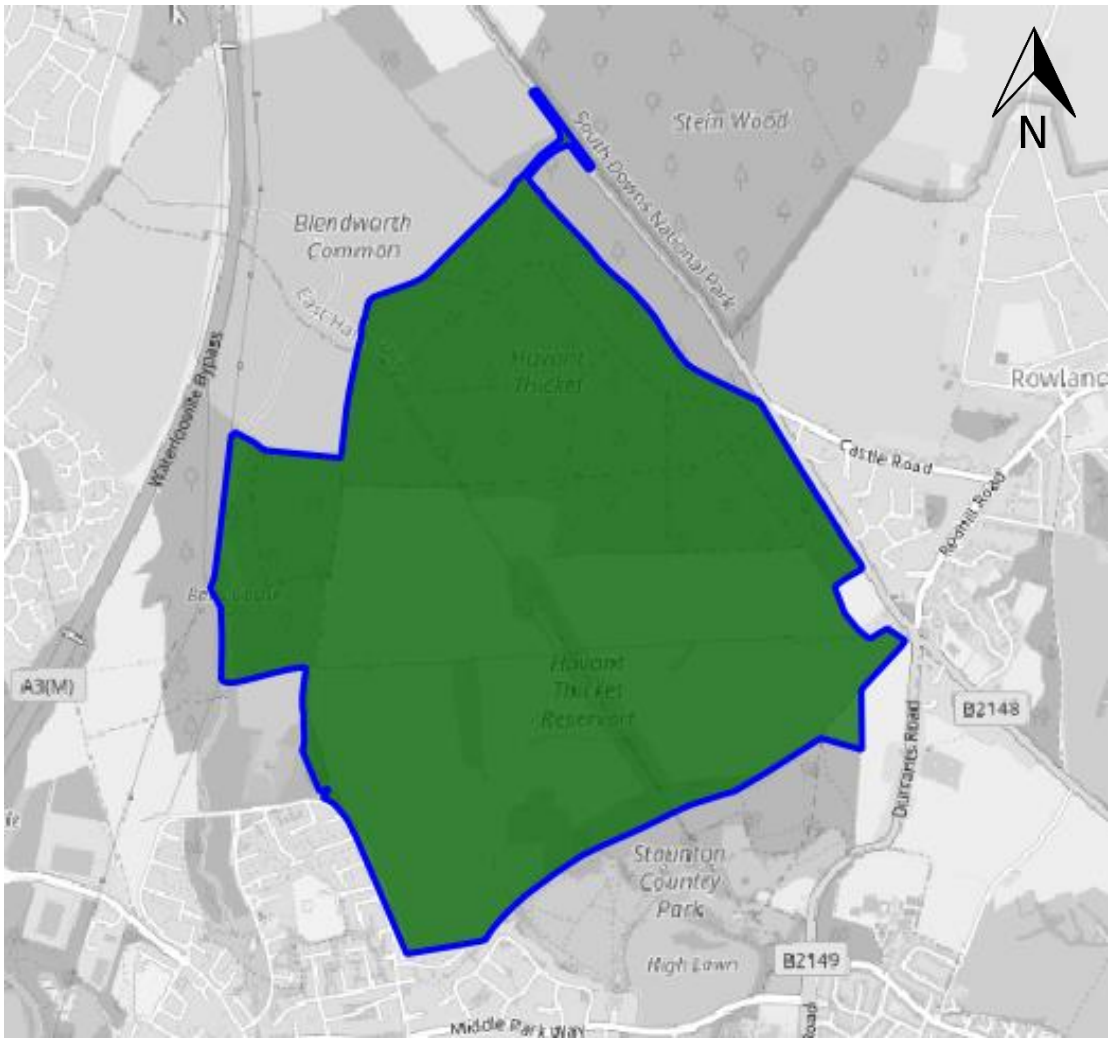
No further bombing records and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-R2-MAP01-A.

It should be noted that the potential to encounter UXO anywhere across a marshalling area cannot be discounted. If UXO is found a re-assessment of the hazard level is required.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: An UXO awareness briefing is recommended for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they can take appropriate action in the event of a suspect find.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is recommended that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

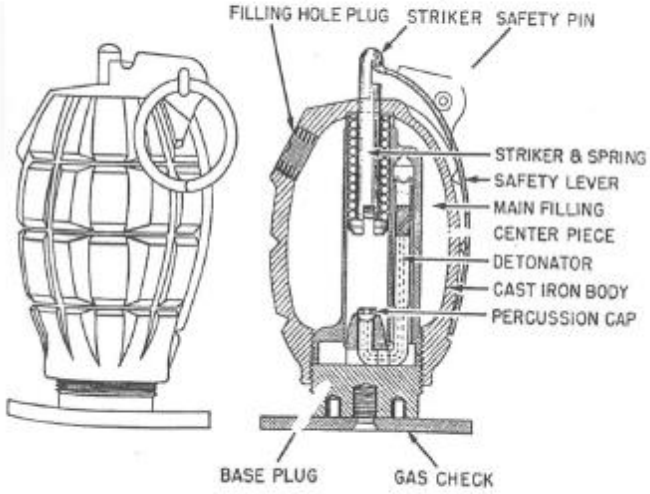
SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.





Information Data Sheet

Category Grenades (British)
Type No. 36 Hand Grenade ('Mills Bomb')



Variants	-	**Dimensions**	101.6mm x 61mm (4" x 2.4")
Weight	2 lbs	**Delay**	4 seconds
Filling	Baratol	**Material**	Cast Iron

Description Lemon-shaped, cast-iron body filled with high explosive. Three holes in the body; one in the base for priming, one near the top for filling; one on the top holding striker.

Function Used as a defence against enemy personnel.





Information Data Sheet

Category Grenades (British)
Type No. 76 Self-Igniting Phosphorus Grenade

Variants -

Dimensions 152.4mm x 63.5mm (6" x 2.5")

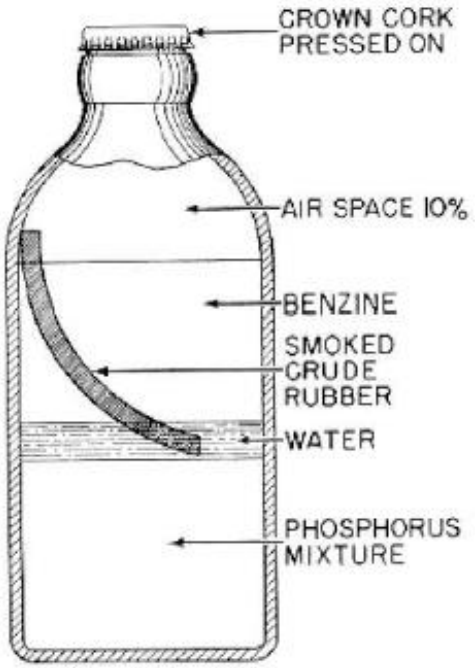
Weight 1lb

Fuze Self-igniting upon breakage

Material Glass

Description Glass bottle filled with white phosphorus, benzene, water and crude rubber.

Function Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.



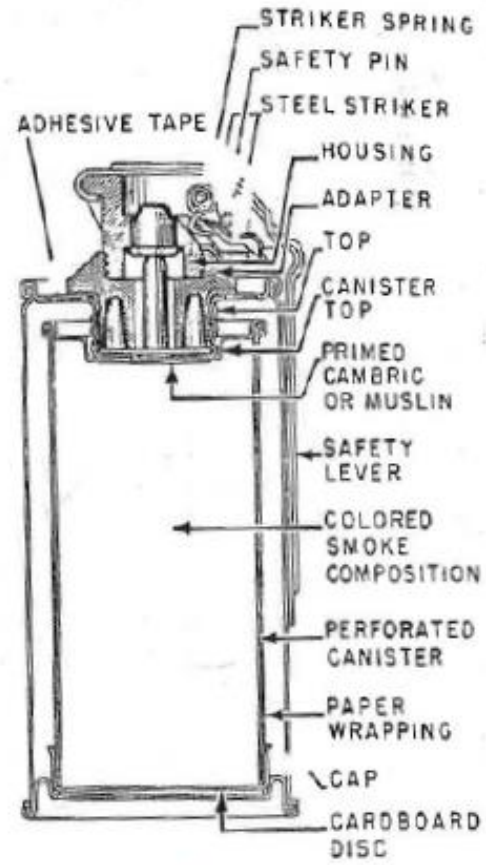




Information Data Sheet

Category Grenades (British)
Type Smoke Hand Grenade

Variants	Numerous
Body Dimensions	66mm x 114.3mm (2.6" x 4.5")
Weight	2lbs
Delay	4 seconds
Filling	Smoke (various colours)
Composition	Tin plate
Description	Green, cylindrical in shape with a perforated canister for emitting smoke.
Function	Used as signalling devices and for training purposes.

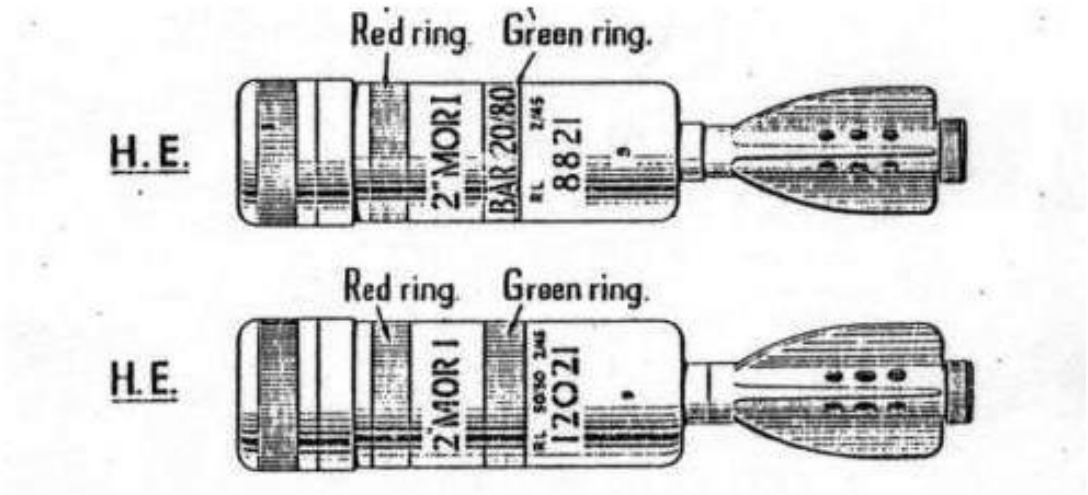






Information Data Sheet

Category Mortar (British)
Type 2-Inch Mortar Bomb



Variants	14	**Length**	11.4" x 2"
Weight	2.5lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	50.8mm (2.0 inches)	**Rate of Fire**	8 rounds per minute

Description Pear-shaped steel body with 6 or 8 vanes. Originally painted buff yellow or dark grey. Filled with c TNT, granular TNT or powdered Amatol. Also smoke, illumination and practice versions.

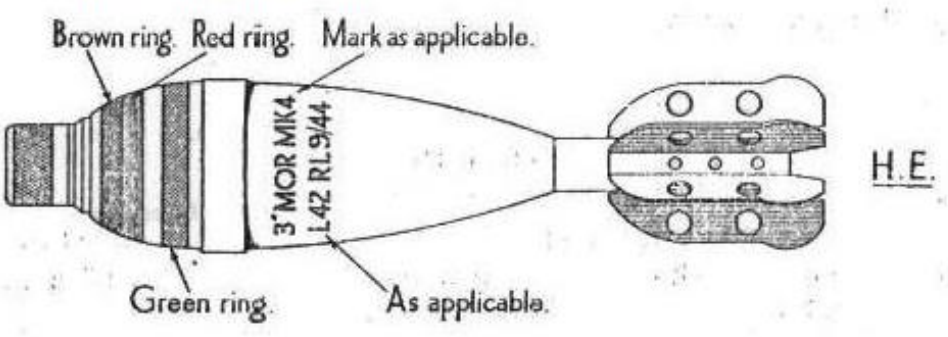
Function Small enough to be carried by one man, with a range limited to 500 yards, the 2" mortar was usec an anti-personnel role.





Information Data Sheet

Category Mortar (British)
Type 3-Inch Mortar Bomb



Variants	2	**Dimensions**	19.3" x 3"
Weight	10lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	76.2mm (3.0 inches)	**Rate of Fire**	12 rounds per minute

Description Pear-shaped steel body with vaned tail fin for stability in flight. Typically filled with high explosive or white phosphorus, the latter dispersing on detonation.

Function Range of up to 1,600 yards, the 3" mortar was used in an anti-personnel role.

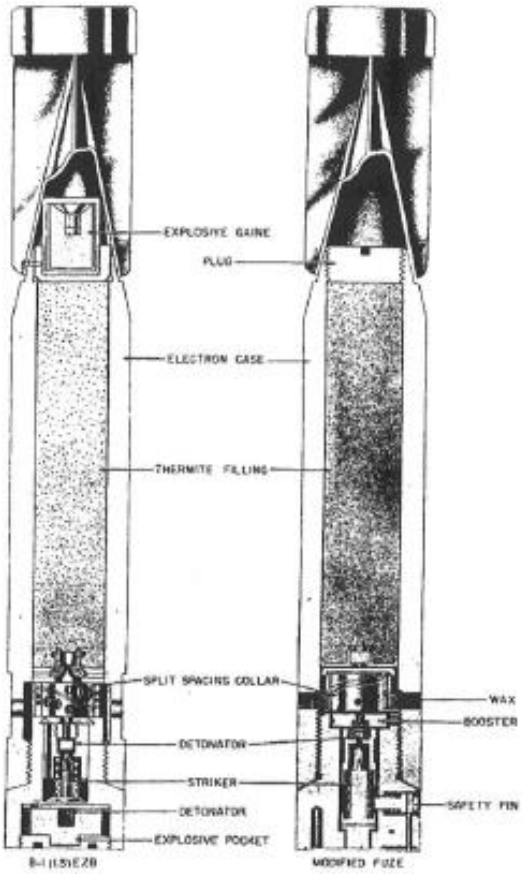




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 1kg

Variants	6
Body Dimensions	350mm x 50mm (13.8" x 1.97")
Weight	1kg & 1.3kg (2.2lbs & 2.86lbs)
Charge Weight	8 -15 gm (0.28 – 0.53 oz) in models with Nitropenta explosive. No charge in B-1 & B-1.3 E types.
Fuze	Impact fuze with safety plug
Composition	Sheet steel
Description	The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze. The after body is tapered to receive the sheet metal, three-fined drum-shrouded tail assembly. The bomb is unpainted magnesium; the tail is dark green.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations.



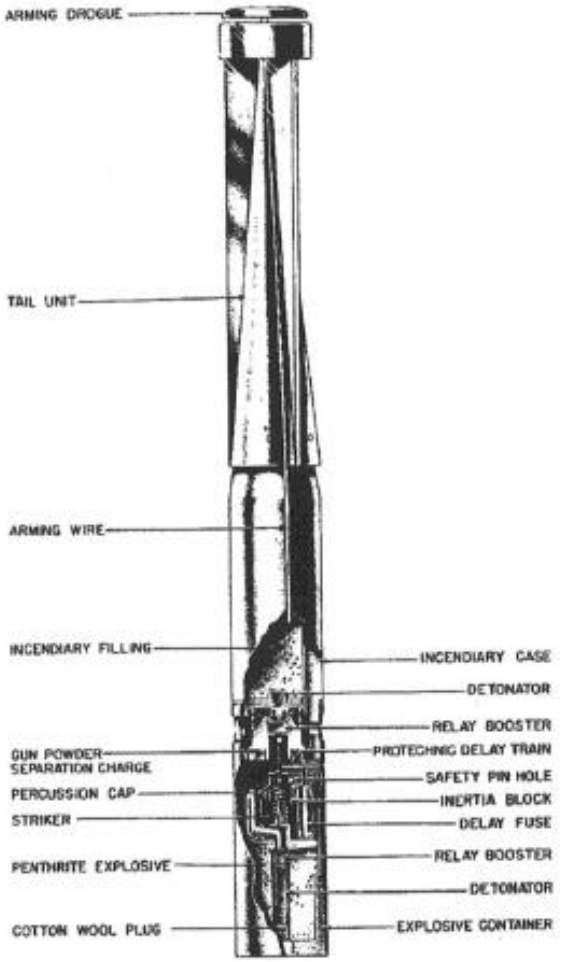




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 2kg

Variants	2
Body Dimensions	525mm x 50mm (20.67" x 1.97")
Weight	2kg & 2.2kg (4.4lbs & 4.85lbs)
Charge Weight	60g (0.13lbs)
Fuze	Impact fuze with screw impact
Composition	Sheet steel
Description	Steel cylinder. Body originally painted green with black explosive section and grey tail.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations. When dropped from 2000m could penetrate iron-concrete roofing.



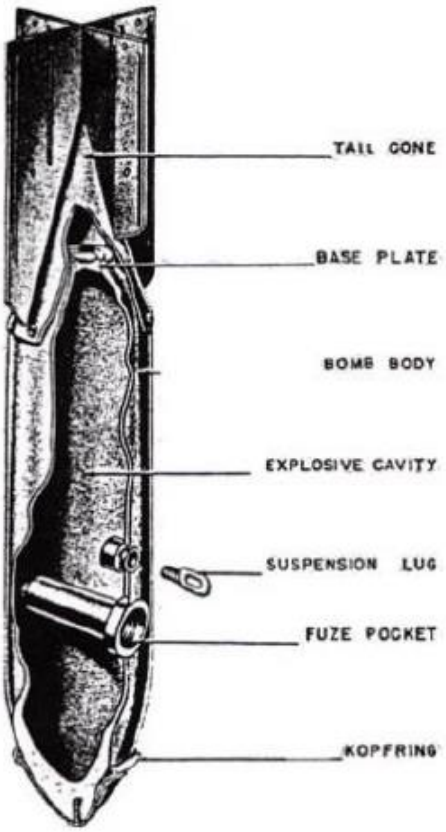




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



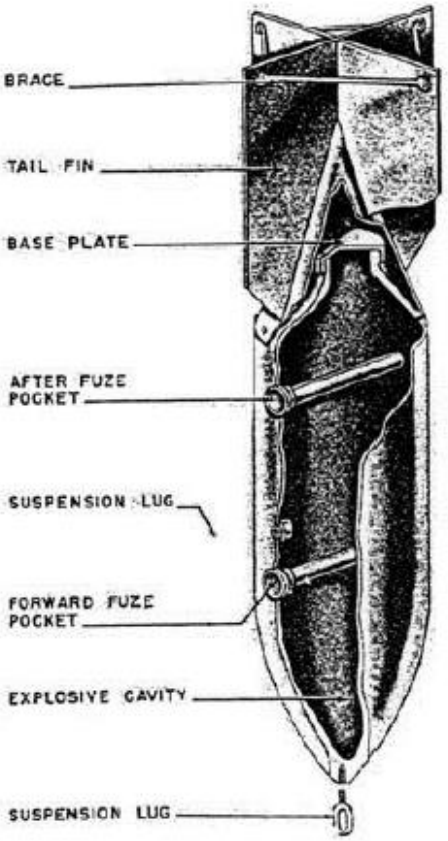




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



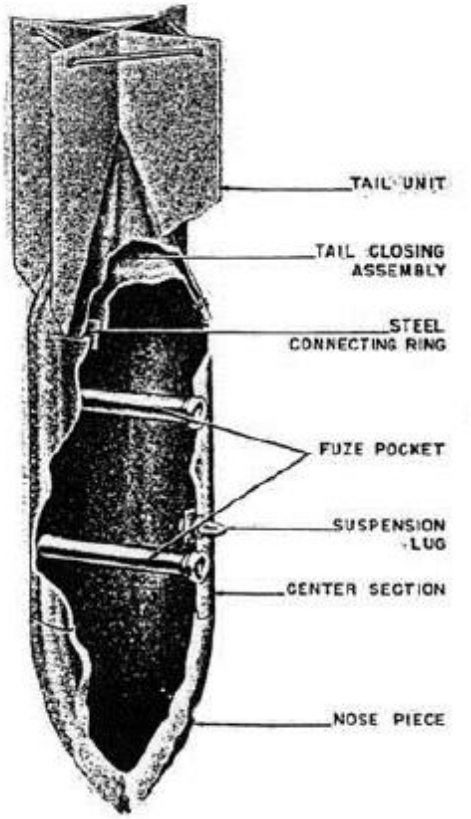




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

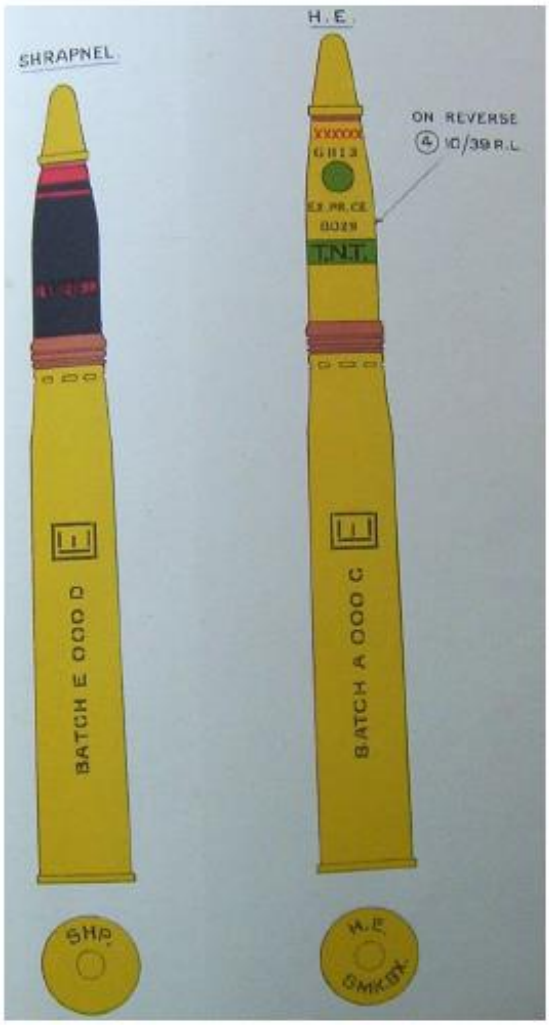
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

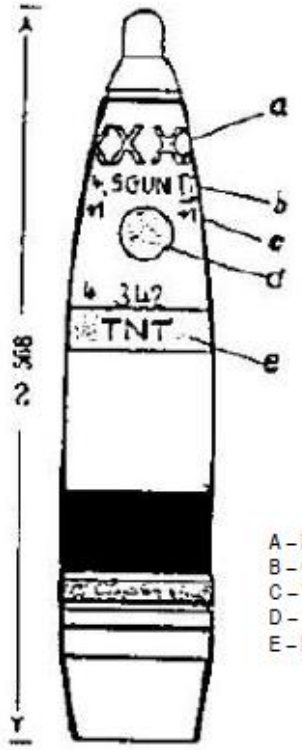
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 Military training areas

Information Data Sheet

Category Military Training Areas

Description:

In September 1939, approximately 235,000 acres of land was occupied by the Army for all purposes, including training. By February 1944, this had risen to 9,800,000 acres for training alone. This land was required for infantry and tank training, for beach assault, and for weapon practice. Where the land was selected, the civilian population was often required to leave and associated accommodations camps for the incoming troops had to be built.

Official training areas tend to have clearly delineated boundaries within which training is to take place. During World War Two (WWII) many areas of open fields and woodland were requisitioned under Defence Regulation 52 by military units stationed in the area. Training in these areas was often not subject to any official rules and regulations, or detailed record keeping.

Some training areas had associated firing ranges whilst others had provisions for armoured vehicle and tank training. Training areas also required firing points, stop butts, and observation and range control bunkers.

In the build-up to D-Day, marshalling areas for British and American troops were established near to the coast, and these areas were commonly used for training exercises using live munitions.



Testing flamethrowers at a WWII Battle Training Area

Hazard:

The types of Unexploded Ordnance (UXO) that could be present at former military training areas varies depending on their operational history. Ordnance used during exercises ranged from Small Arms Ammunition (SAA) to grenades, defensive mines, mortars and shells, and unconventional weapons such as flamethrowers.

'Dry' training areas will have primarily used blank ammunition, although even these areas are likely to have used live munitions at some stage.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

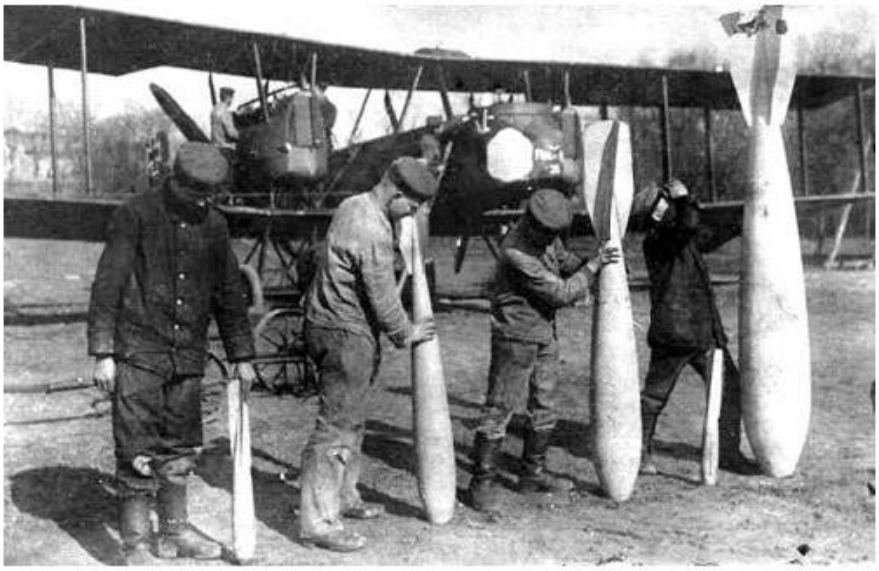
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.3 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.4 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 [redacted] incident list

11th September 1940

1No. HE bomb fell on Leigh Park, approximately 0.4km south-southeast of the Site.

29th September 1940

24No. IBs fell on Leigh Park, approximately 0.1km south-southeast of the Site.

27th October 1940

5No. HE bombs and several IBs fell on Middle Park Farm, approximately 0.5km west-southwest of the Site.

10th March 1941

1No. HE bomb fell on Rowlands Castle golf course, approximately 0.4km east of the Site.

11th March 1941

8No. HE bombs fell on open ground of Oaklands, approximately 0.2km northeast of the Site.

11th April 1941

4No. HE bombs fell on Havant Thicket, on the Site.

29th April 1941

1No. HE bomb fell on the northern part of Havant Thicket, on the Site.

17th April 1942

4No. HE bombs fell on Rowlands Castle golf course, approximately 0.3km east-northeast of the Site.

8th March 1943

Several IBs fell on Middle Park Farm, approximately 0.5km west-southwest of the Site.

16th August 1943

2No. HE bombs fell on Havant Thicket, on the Site.

2No. HE bombs fell on the eastern part of Havant Thicket, approximately 80m northeast of the Site.

23rd August 1943

1No. HE bomb fell on Havant Thicket, on the Site. This was recorded as an UXB.

24th February 1944

1No. IB fell on Bell's Copse, on the Site. This was recorded as an UXIB.

27th April 1944

5No. HE bombs fell on Havant Thicket, on the Site.

5No. HE bombs fell on The Holt, approximately 0.2km east-southeast of the Site.

Appendix 6 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Graves C, The Home Guard of Britain, 1943

Hind R W, The Naval Camps of Bedhampton and Leigh Park, 2017

Jeffery D, Petersfield at War, 2004

Leete J, In Time of War Hampshire, 2007

Marsham P, Rowlands Castle in World War Two, 1994

Morris J, German Air Raids on Britain 1914-1918, 1993

Pile J, Belmont Park, Bedhampton the Estate, The House and its People, 2012

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 7 General Notes

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2. The report should not be used by third parties without prior consultation with Zetica Ltd. The copyright for this report remains with Zetica Ltd.
3. No part of this report may be reproduced, published or amended without prior written consent from Zetica Ltd.
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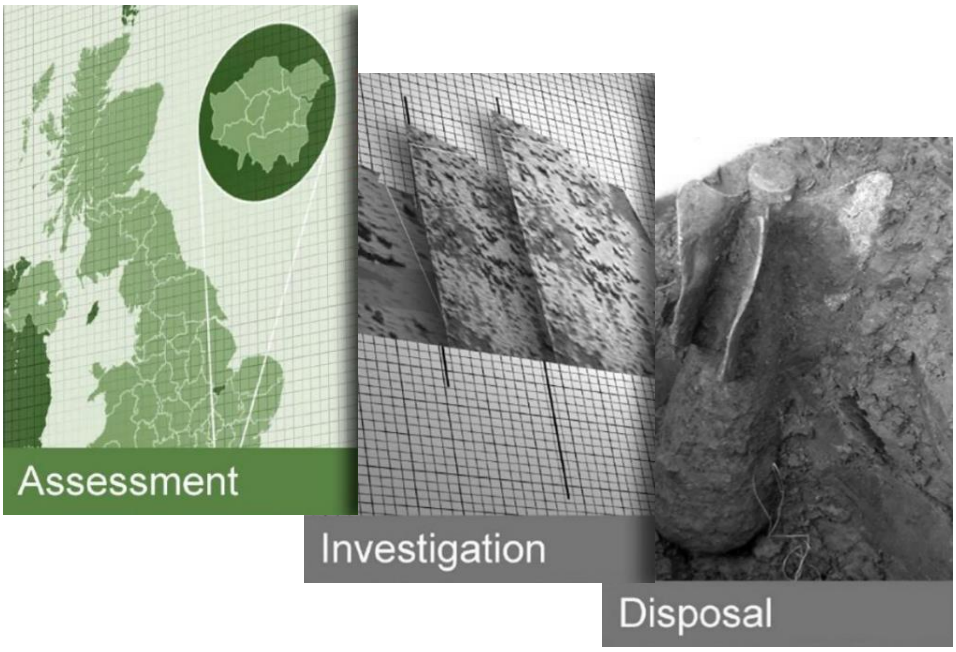
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- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R11**
Revision	**A**
Project Title	**D Site**
Client	**Southern Water**
Date	**5th April 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: Potential hazard from Unexploded Bombs (UXBs) on the eastern part of the Site.

Key actions: Explosive Ordnance Clearance (EOC) engineer supervision is required for excavations and deep UXB detection is required to clear Horizontal Directional Drilling (HDD) routes within the moderate hazard zone. An Unexploded Ordnance (UXO) awareness briefing is recommended for all staff involved in excavations.

UXO hazard assessment

Records have been found indicating that at least 6No. High Explosive (HE) bombs fell in the immediate vicinity of the eastern part of the Site during World War Two (WWII). Langstone Harbour, in the vicinity of the Site, was heavily attacked on multiple occasions.

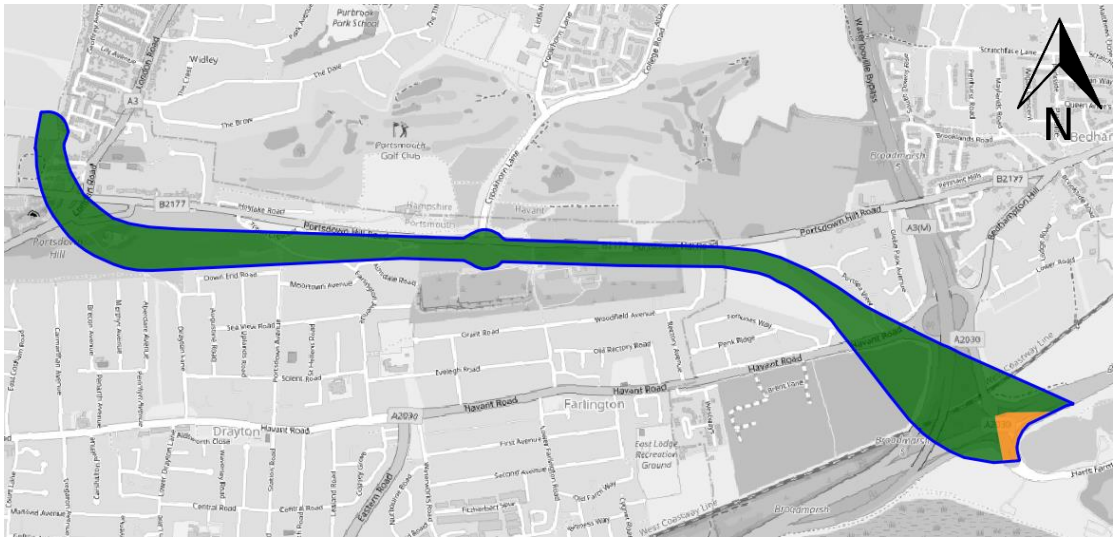
Given the number and intensity of raids, it is considered possible that an UXB may have fallen unnoticed on the eastern part of the Site, which comprised marshland and tidal mudflats. This part of the Site is assigned a moderate UXO hazard level.

No further bombing and no other significant sources of UXO hazard have been identified on the remainder of the Site, which is assigned a low UXO hazard level.

It is considered that the UXO hazard level on the Site can be zoned from low to moderate, as shown in the figure below, reproduced asFigure 8 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R11-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

The main findings of the report are summarised below.

- During the 1860s the Portsdown Military Lands were established on the western part of the Site. The lands were used to establish a series of defensive Palmerston Forts overlooking Portsmouth. The nearest was Fort Purbrook, adjacent to the Site.
- During World War One (WWI) and WWII Fort Purbrook was used primarily as barrack accommodation and a centre for civil defence.
- After WWII, the Portsdown Military Lands were de-requisitioned. Fort Purbrook was used as a Naval Radar School until 1968. It is now used as an activities centre by Portsmouth City Council.
- During WWII the main strategic targets in the vicinity of the Site included Langstone Harbour, military barracks and depots, aircraft manufacturing works, public utilities, and anti-invasion defences.
- Records have been found indicating that during WWII, at least 6No. HE bombs fell in the immediate vicinity of the eastern part of the Site, which comprised marshland.
- There were 16No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and HDD to 20m bgl.

Risk assessment

The Table below, reproduced as Table 4 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

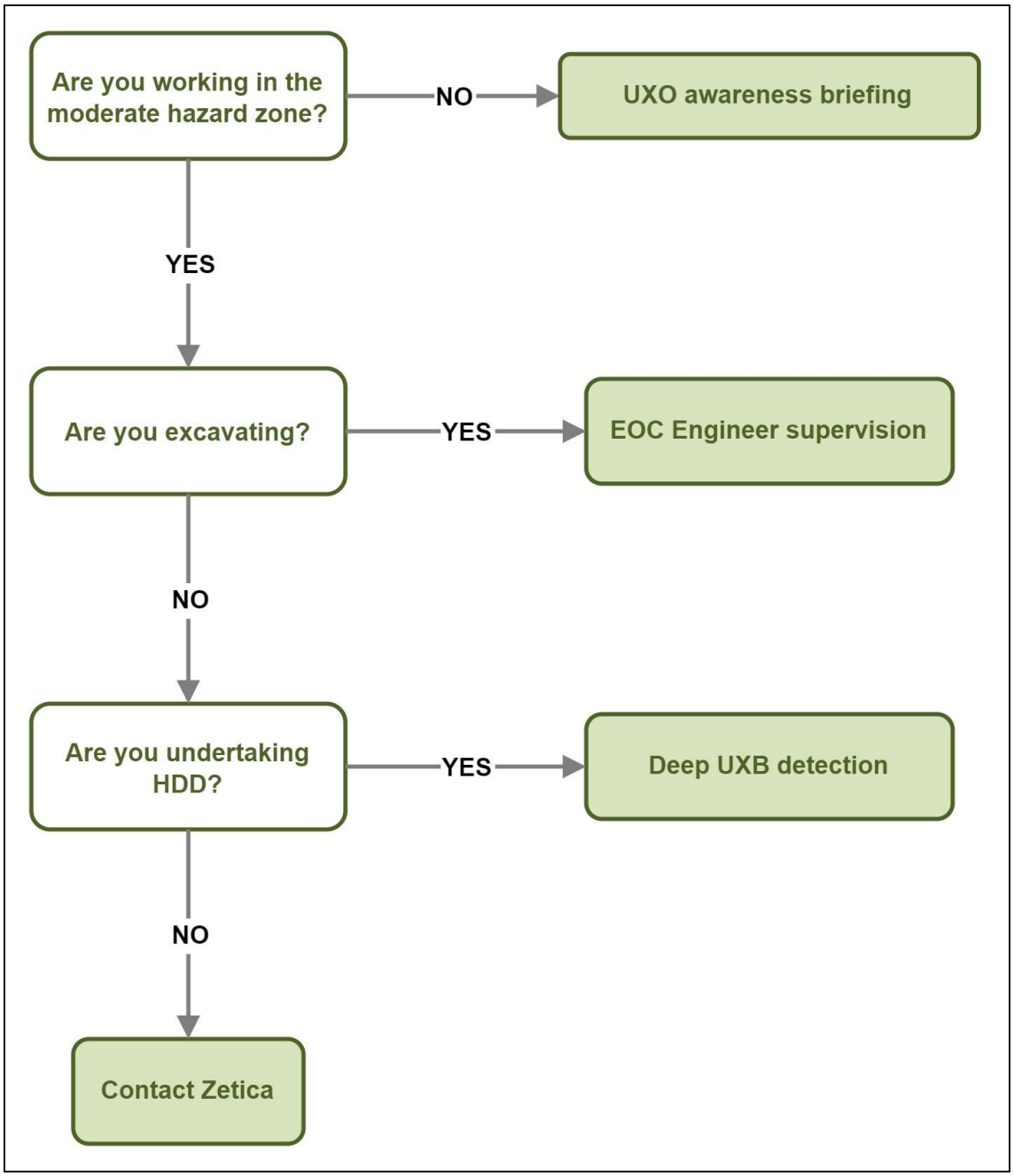
UXO risk assessment for the Site

Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Moderate	UXB	Excavations	3	2	6	3	5	15	Moderate
		HDD	2	3	6	3	4	12	Moderate
	Other UXO	Excavations	1	1	1	1	4	4	Low
		HDD	1	1	1	1	3	3	Low
Low	UXB	Excavations	1	1	1	1	5	5	Low
		HDD	1	1	1	1	4	4	Low
	Other UXO	Excavations	1	1	1	1	4	4	Low
		HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood									
HDD = Horizontal Directional Drilling									

Risk mitigation plan

The Figure below, reproduced as Figure 8 in the main report, provides a risk mitigation plan to ensure that the UXO risk for the proposed works is reduced to As Low As Reasonably Practicable (ALARP).

Recommended risk mitigation plan for the Site



Further details on the recommended risk mitigation techniques are given in Section 8.2 of this report.

Table below, reproduced as Table 5 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**
Excavations		**EOC Engineer supervision –** to ensure safety and minimise delays, EOC Engineer supervision is recommended.
HDD		**Deep UXB detection** – an intrusive magnetometer survey should be undertaken until either maximum bomb penetration depth or maximum drilling depth is reached.

In summary, it is recommended that excavations within the moderate hazard zone are supervised by an EOC Engineer.

To clear the proposed HDD route, we recommend that deep UXB detection is undertaken.

An UXO awareness briefing is recommended for all staff involved in excavations.

What do I do next?

If you require a quote for risk mitigation or have any comments, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS data

P14032-24-R11-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
AT	Anti-Tank
ALARP	As Low As Reasonably Practicable
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DAB	Delayed Action Bomb
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HMS	His Majesty's Ship
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
PoW	Prisoner of War
RA	Royal Artillery
RAF	Royal Air Force
RBL	Rifled Breech-Loading
RE	Royal Engineers
RML	Rifled Muzzle-Loading
RN	Royal Navy
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
UXPM	Unexploded Parachute Mine
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route of approximately 3.7km between Widley and Langstone near Portsmouth, Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Portsmouth City Council, The Portsmouth History Centre and Hampshire Record Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

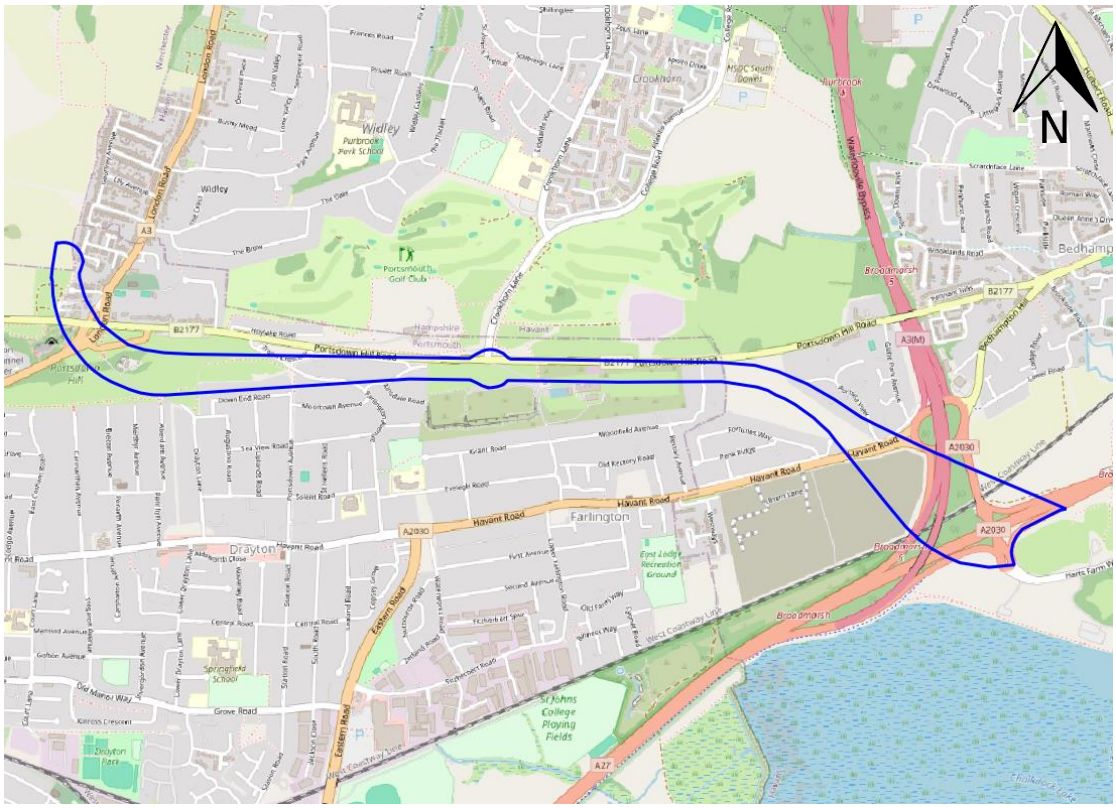
2.1 Site location

The Site commences at Widley on Ordnance Survey National Grid Reference (OSNGR) SU 666066 and terminates near Langstone on OSNGR SU 700057. It is located approximately 4.4km northeast of central Portsmouth.

The Site comprises open ground, hardstanding, residential buildings, and several roadways. It is bounded to the north and south by open ground, roadways, and residential buildings, and to the east and west by open ground and roadways.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Portsdown Military Lands

Between the 1860s and 1950s the Portsdown Military Lands encroached on the western part of the Site. A brief military history of the lands is provided below.

Pre-WWI

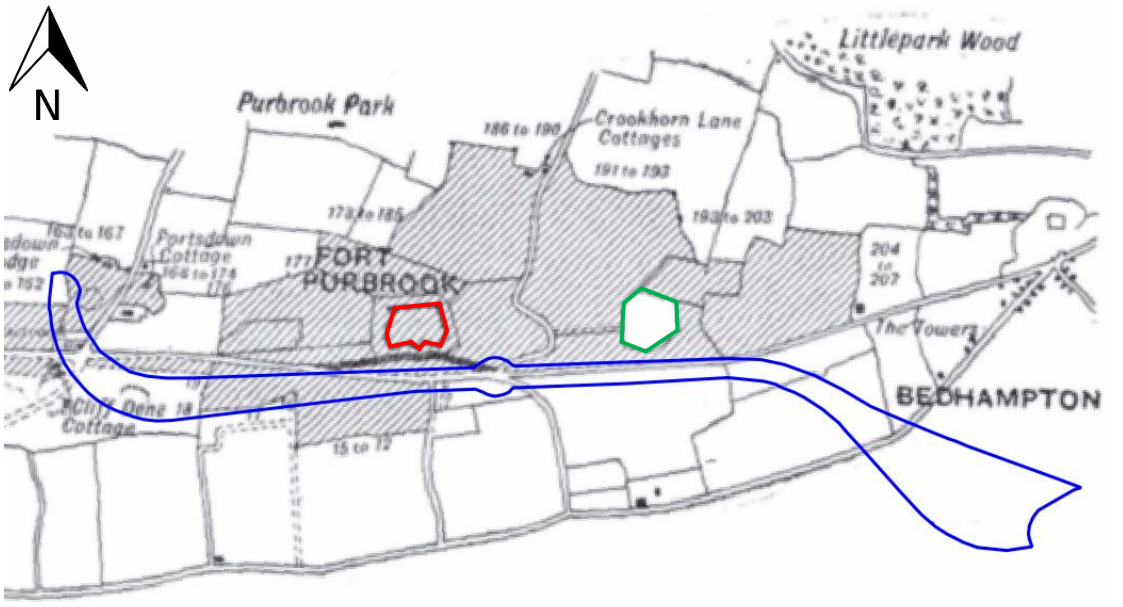
In 1861 the War Office (WO) requisitioned an area of land encompassing Portsdown Hill, encroaching on the western part of the Site.

Designated as the Portsdown Military Lands, it was used to establish a series of defensive fortifications overlooking Portsmouth, known as Palmerston Forts. Designed to protect Portsmouth and its important naval dockyard from a possible inland attack, 2No. such forts were constructed in the vicinity of the Site.

The nearest was Fort Purbrook (SU 628069), adjacent to the Site. An accompanying fortification, the Farlington Redoubt (SU 687065), was established to the east of Fort Purbrook, also adjacent to the Site.

Figure 2 is a plan of the Portsdown Military Lands dating from 1928. The 2No. forts have been highlighted.

Figure 2 Plan of the Portsdown Military Lands, 1928



Source: MoD *Not to Scale*

Legend		
	Site boundary	Portsdown Military Lands
	Fort Purbrook	Farlington Reboubt

The Palmerston Forts were of polygonal design and comprised multiple heavy gun batteries facing inland. They had accompanying storage magazines and accommodation facilities for officers and other ranks.

By 1893 Fort Purbrook's armaments included 7No. 7-inch (") rifled breech-loading (RBL) guns, 7No. 64-pounder (-pdr) rifled muzzle-loading (RML) guns, and 4No. 8" RML Howitzers.

Records indicate that in 1898 the Farlington Redoubt was armed with 7No. 64-pdr RML guns.

By 1907 the Palmerston Forts had been disarmed.

WWI

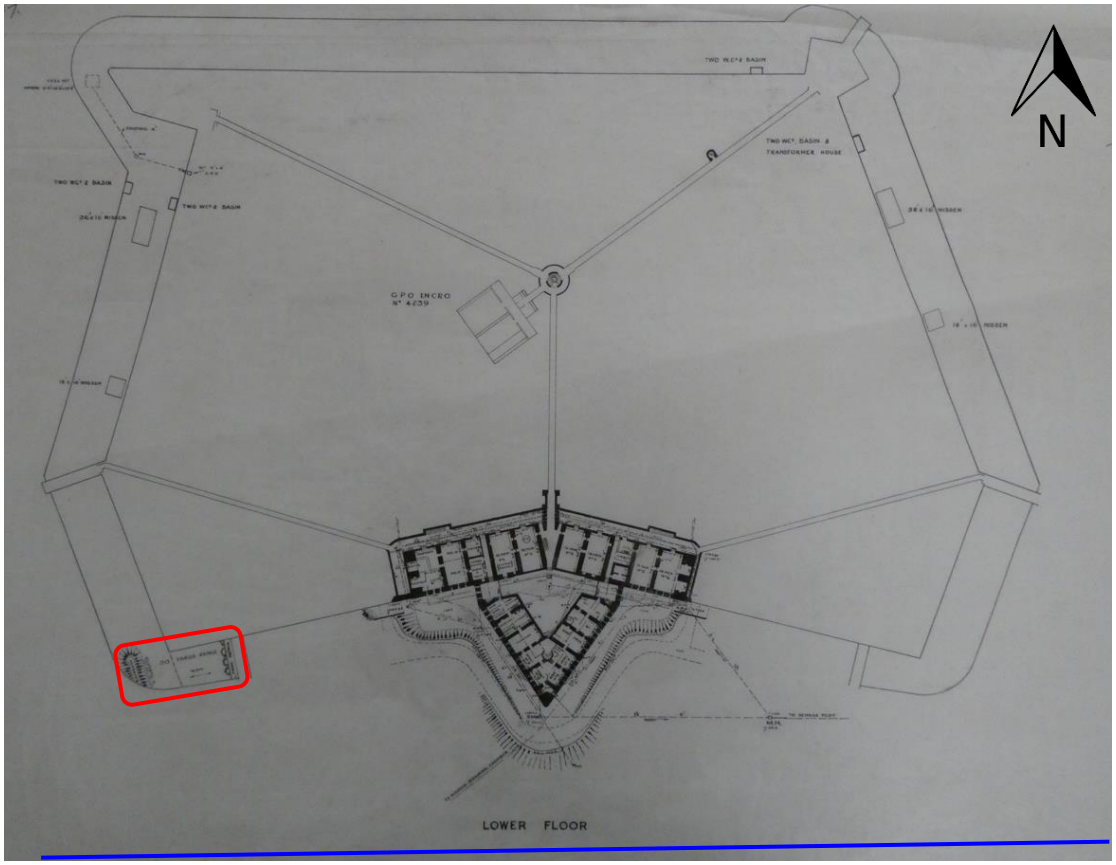
During WWI the Palmerston Forts remained in use primarily as barrack accommodation. They were also incorporated into regional Anti-Aircraft (AA) defences (see Section 3.2.1).

Interwar

After WWI Fort Purbrook remained in use as military barracks.

Figure 3 is a plan of Fort Purbrook, dating from 1926. 1No. 30-yard (yd) rifle range has been identified, approximately 50m north of the Site. This shows that the range was contained within the fort's dry ditch, below the Site ground level.

Figure 3 Plan of Fort Purbook, 1926



Source: The National Archives *Not to Scale*

Legend	Site boundary	Rifle range

In 1926 Fort Purbrook and Farlington Redoubt were decommissioned. The forts subsequently fell into disrepair. By the start of WWII Farlington Redoubt had been demolished, and the foundations had been excavated for use as a chalk pit.

WWII

During WWII the Palmerston Forts again served as important regional military centres.

In June 1940 Fort Purbrook was re-occupied, and became an ambulance base, barracks, and centre for civil defence.

During this period numerous anti-invasion defences were established on Portsdown Hill (see Section 3.2.2).

Records indicate that several mock-invasion exercises were undertaken in the immediate vicinity of Portsdown Hill (see Section 3.2.2). It is considered unlikely that these would have taken place in the immediate vicinity of the Site, which was located in close proximity to residential buildings.

Records indicate that in 1944, the chalk pit at the former Farlington Redoubt was temporarily used as a live-fire range (see Section 3.3).

Post-WWII

After WWII the majority of the Portsdown Military Lands were released for civilian use.

Fort Purbrook was used as a Naval Radar School until 1968. It is now used as an activities centre by Portsmouth City Council.

The Farlington Redoubt remains in use as a chalk quarry. It is currently operated by L&S Waste Management Limited.

Potential UXO hazard

Between the 1860s and 1950s the western part of the Site encroached on the Portsdown Military Lands.

No records have been found to indicate that any live-fire military training took place on the Site, and no evidence of significant military training has been identified on the Site on historical aerial photography.

It should be noted that given part of the Site was located within the Portsdown Military Lands, the potential for encountering surface-level or shallow-buried UXO on the Site, whilst unlikely, cannot be totally discounted.

The Portsdown Military Lands are not considered to provide a significant source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

Details of the military defences in the vicinity of the Site are given below.

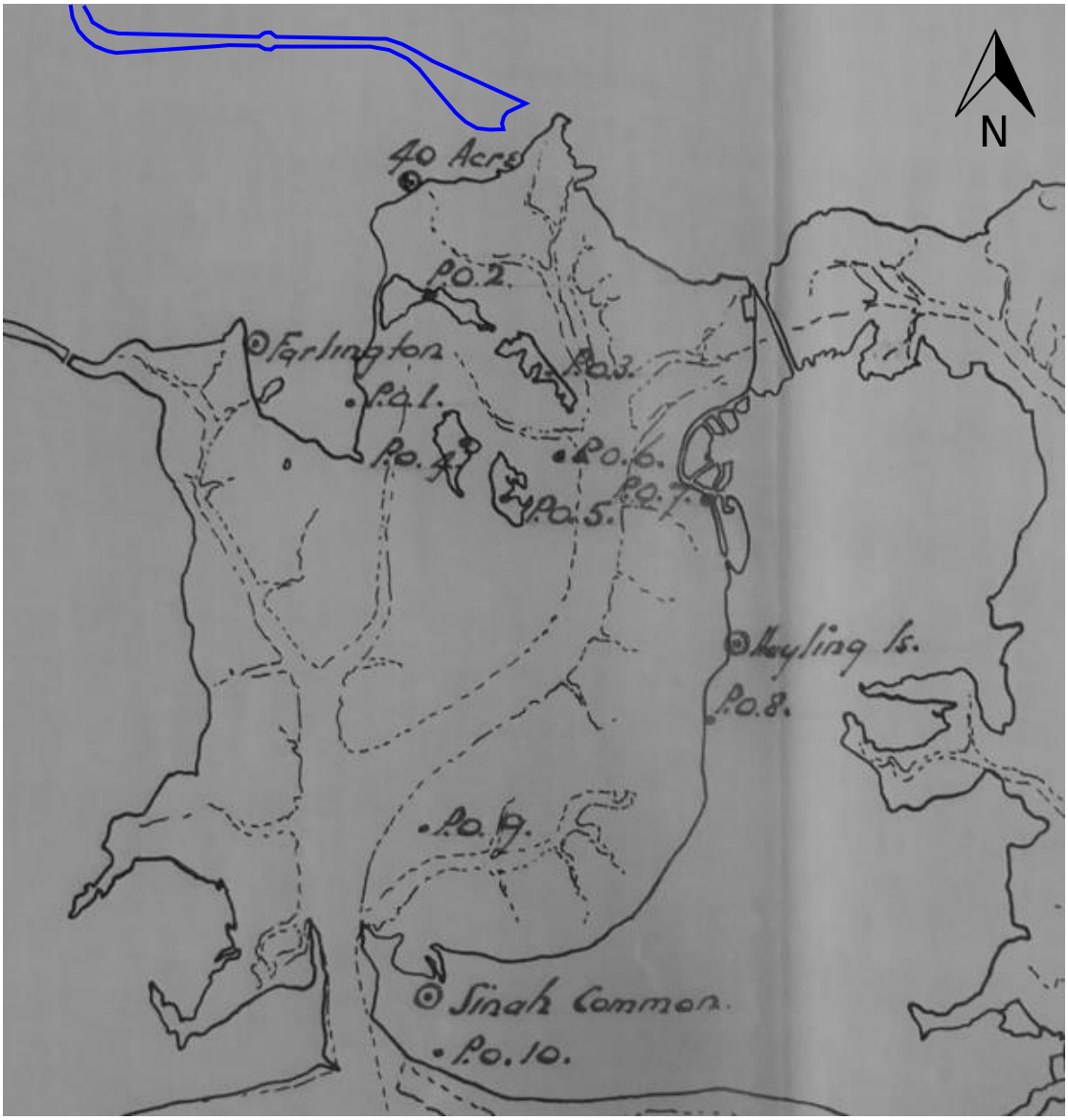
3.2.1 Bombing decoys

During WWII 11No. bombing decoys were established in and around Langstone Harbour, in the vicinity of the Site. These comprised 10No. Naval (N) Series and 1No. Civil Starfish (SF) Series decoys, designed to replicate the docks and harbour facilities of Portsmouth using imitation lights and controlled fires.

The nearest of these was located on North Binness Island (SU 695046), within approximately 0.9km south of the Site, and was designated PO2. Several associated observation posts were also established in the vicinity of Langstone. 1No. of these was located at Forty Acre Farm (SU 692056), approximately 0.3km southwest of the Site.

Figure 4 is a plan of Langstone Harbour dating from WWII. It shows the location of the 11No. decoys and associated observation posts.

Figure 4 Plan of the Langstone Harbour bombing decoys, WWII



Source: National Archives *Not to Scale*

Legend	Site boundary

The decoys in Langstone Harbour were effective in diverting German aircraft away from Portsmouth on several occasion (see Section 4.2).

Records indicate that there were at least 6No. air raids on the Langstone Harbour bombing decoys. Decoy PO10, within approximately 6.3km south of the Site, was the most successful SF Series decoy of WWII.

Potential UXO hazard

Records indicate that the bombing decoys in the vicinity of the Site were very successful in diverting bombs away from Portsmouth during WWII.

Given the nature of the eastern part of the Site and surrounding area, comprising mudflats, marshland, and open water, bombs were often missed and not accurately recorded.

Bombing decoys are considered to provide a possible source of UXO hazard to the eastern part of the Site. Further details on [redacted] on the Site are given in Section 4.2.

3.2.2 Anti-Aircraft (AA) guns

During WWI there were 17No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Purbrook (SU 678064), approximately 0.1km north of the Site. It was armed with 1No. 18-pdr gun.

During WWII there were 16No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located off Crookhorn Lane, Morelands (SU 686070), approximately 0.7km north of the Site. It was armed with 4No. 3.7" guns.

The nearest recorded WWII AA shell incident to the Site is described below.

4th March 1941

1No. AA shell fell on Purbrook Park, approximately 0.6km north of the Site. This was recorded as an Unexploded AA (UXAA) shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.2.3 Anti-invasion defences

During summer 1940, the Wymering Stop Line was established along the Portsdown Hill to contain a potential German invasion. Several anti-invasion defences were established on and in the vicinity of Site.

Several Anti-Tank (AT) blocks were established in front of Fort Purbrook (SU 678063), adjacent to the Site. 2No. pillboxes were situated near Fort Widley (SU 664064), within approximately 0.1km west of the Site.

Local anti-invasion defences were manned primarily by 'B' Company, 11th (Hampshire) Battalion.

Records indicate that in mid-1941, the 11th (Hampshire) Battalion undertook several mock-invasion exercises on Portsdown Hill.

These involved manning anti-invasion defences along Portsdown Hill as a rehearsal for a potential enemy invasion. It is considered unlikely that these exercises would have taken place in the immediate vicinity of the Site, which was located in close proximity to residential buildings.

After WWII, the local anti-invasion defences in the vicinity of the Site were removed.

Potential UXO hazard

Defended positions often had associated munitions caches which may have stored Small Arms Ammunition (SAA), in addition to Land Service Ammunition (LSA) such as grenades and mortars.

These caches were typically removed at the end of WWII, although the possibility of local munitions disposal around defended positions cannot be totally discounted.

Anti-invasion defences are not considered to provide a significant source of UXO hazard to the Site.

3.2.4 Home Guard

During WWII, the 31st (Cosham) Hampshire Home Guard Battalion operated in the vicinity of the Site.

The Home Guard was responsible for patrolling local transport links and strategic targets, as well as manning regional anti-invasion defences along Portsdown Hill (see Section 3.2.2).

Potential UXO hazard

It should be noted that records of Home Guard activities were rarely kept, and training activities were usually unofficial or unsanctioned.

Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often buried or dumped in ad-hoc locations.

Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

3.3 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any firing ranges or military training areas on the Site have been found. The nearest is detailed below.

3.3.1 Farlington Redoubt chalk pit range

In 1944, the former Farlington Redoubt, adjacent to the Site, which had been converted into a chalk pit, was temporarily requisitioned by the WO for use as a revolver and grenade range (see Section 3.1.1 and Plate 3).

The range was likely used by troops stationed in Marshalling Area 'A', within approximately 0.8km northeast of the Site, which was used to concentrate troops and supplies in preparation for D-Day, the Allied invasion of northern Europe.

By the end of WWII, the chalk pit had returned to commercial use. It has since gone through several phases of redevelopment and is currently operated by L&S Waste Management Limited.

Potential UXO hazard

Records indicate that firing activities at Farlington Redoubt were contained within the excavated chalk pit. Whilst no evidence has been found to indicate that this activity encroached onto the Site, the possibility of overspill cannot be totally discounted.

Farlington Redoubt chalk pit range is not considered to provide a significant source of UXO hazard to the Site.

3.4 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Flying Corps (RFC) Tipnor, approximately 3.6km southwest of the Site. It was established in 1917 as No. 15 Kite Balloon Base (KBB). It was closed in August 1919 and reverted to agricultural land.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Gosport, approximately 9.3km southwest of the Site. It was used for the testing of torpedo bomber aircraft and for flight training purposes.

After the end of WWII RAF Gosport was handed to the Royal Navy (RN) as shore establishment His Majesty's Ship (HMS) Siskin. It closed in 1956 and the land was subsequently redeveloped as housing.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.5 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.6 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

Records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Portsmouth

Portsmouth was heavily bombed during WWII. There were 69No. recorded air raids on the city, with heaviest raids occurring on 24th August 1940, 10th January 1941, and 10th March 1941.

Bombing was concentrated on Portsmouth's naval base and city centre. Military establishments in the region such as airfields, naval bases and radar stations were specifically targeted. Records for heavy raids on many of the regions' airfields and naval bases were suppressed until after WWII.

To help counter heavy bombing raids, 11No. bombing decoys were established in and around Langstone Harbour to divert German aircraft over the relatively unpopulated island of Hayling and local mudflats (see Section 3.2.1). The decoys were successful on at least 6No. occasions, including an incident on the 17th April 1941, when over 140No. enemy aircraft were lured away and unloaded in excess of 200No. air-dropped munitions into Langstone Harbour and the surrounding marshland.

A bombing decoy on Sinah Commons, approximately 6.3km south of the Site, attracted such an intense level of bombing that it became known as the most successful SF decoy of the war.

By the end of WWII it was estimated that at least 300No. High Explosive (HE) bombs had fallen on Langstone Harbour.

The western part of the Site was located in an area that remained vulnerable to overspill from these heavy raids and was subjected to 'tip and run' raids, where bombers would jettison their unused bombs on opportunistic targets.

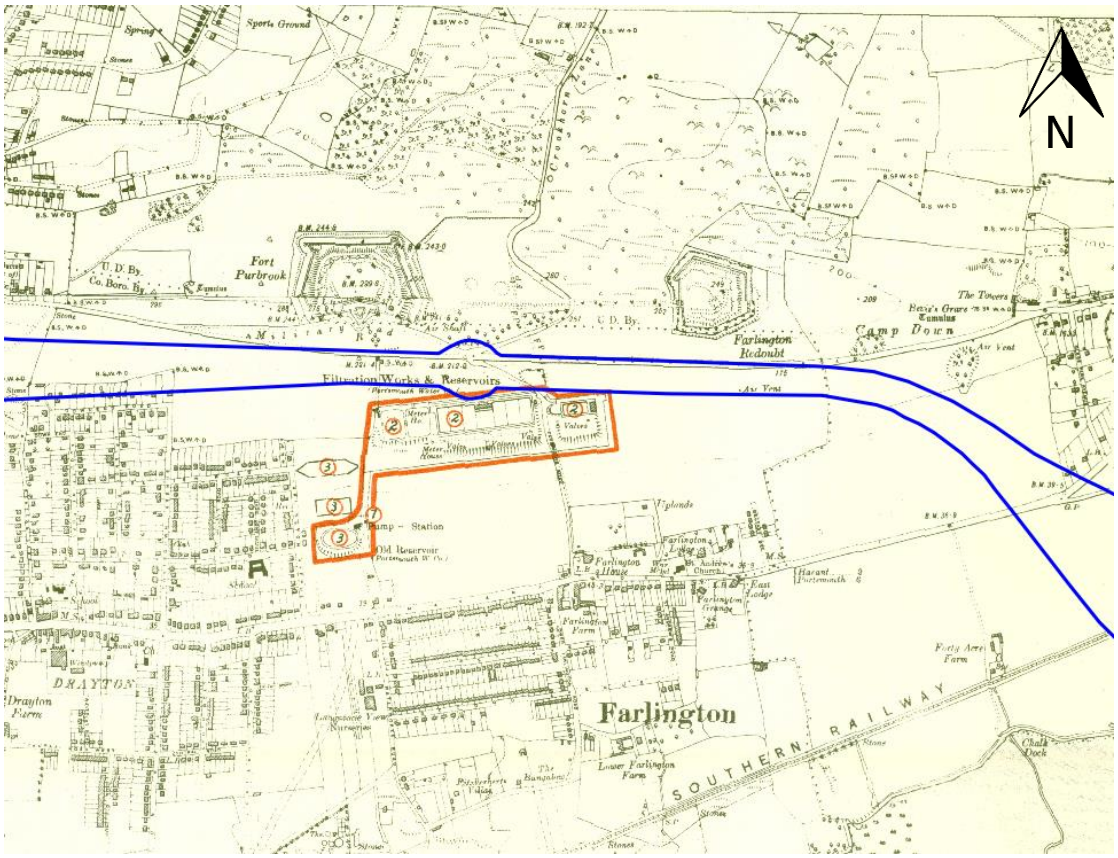
4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including Langstone Harbour, military barracks and depots, aircraft manufacturing works, public utilities, and anti-invasion defences.

Figure 5 is a Luftwaffe target map of Farlington, dating from April 1939. This shows the Portsmouth Water Co. filtration works, adjacent to the Site.

Figure 5 Luftwaffe target map of Farlington, April 1939



Source: The National Archives *Not to Scale*

Legend	Site boundary

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Portsmouth CB	**1,221**	**34**	**7**	**1,262**	**136.8**
Havant and Waterloo UD	**375**	**39**	**9**	**423**	**35.0**
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Gosport MB	587	4	10	601	97.3
Petersfield RD	457	9	19	485	8.6

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further recorded bombing incidents in the vicinity of the Site.

30th September 1940

1No. HE bomb fell on the Bedhampton Chalk Pit, Portsdown Hill Road, approximately 0.4km north-northeast of the Site.

11th November 1940

Several IBs fell on open ground south of Manor Farm, Bedhampton, approximately 40m north-northeast of the Site.

19th November 1940

1No. HE bomb fell on open ground adjacent to the Portsmouth Water Works Co. Upper Reservoirs, Farlington, adjacent to the Site.

1No. HE bomb fell on open ground off Crookhorn Lane, approximately 30m north of the Site.

1No. HE bomb fell on the junction of Grant Road and Farlington Road, approximately 0.2km south of the Site.

1No. HE bomb fell on Lower Farlington Road, approximately 0.2km south of the Site.

10th March 1941

Several IBs fell on Widley and Purbrook, within approximately 0.3km northeast of the Site.

8th April 1941

1No. HE bomb fell on open ground between Military Road and Fort Purbrook, approximately 20m north of the Site.

1No. HE bomb fell on open ground off Farlington Road, approximately 0.1km south of the Site.

17 – 18thApril 1941

2No. HE bombs fell on open ground north of Portsdown Hill Road, Bedhampton, within approximately 0.1km north of the Site.

1No. HE bomb fell on the garden of 74 The Brow, Purbrook, approximately 0.3km north of the Site. This was recorded as an UXB.

4th May 1941

Several IBs fell on Farlington, within approximately 0.3km south of the Site.

7th May 1941

Several IBs fell on Farlington, within approximately 0.3km south of the Site.

1st June 1941

2No. HE bombs fell on Geoffrey Avenue, Widley, approximately 0.3km north-northeast of the Site.

5th June 1941

1No. HE bomb fell on the north side of Langstone Harbour, south of Bedhampton, approximately 0.2km south of the Site.

8th March 1943

1No. HE bomb fell on the Auriol Estate, approximately 0.1km southwest of the Site.

1No. Oil Bomb (OB) fell on Portsdown Hill, Bedhampton, approximately 0.2km north-northeast of the Site.

15th – 16th August 1943

2No. HE bombs fell in the sea at Broad Marsh, within approximately 60m south of the Site.

Several IBs fell on Broad Marsh, within approximately 50m south of the Site.

Several IBs fell on Fort Purbrook, within approximately 80m north of the Site.

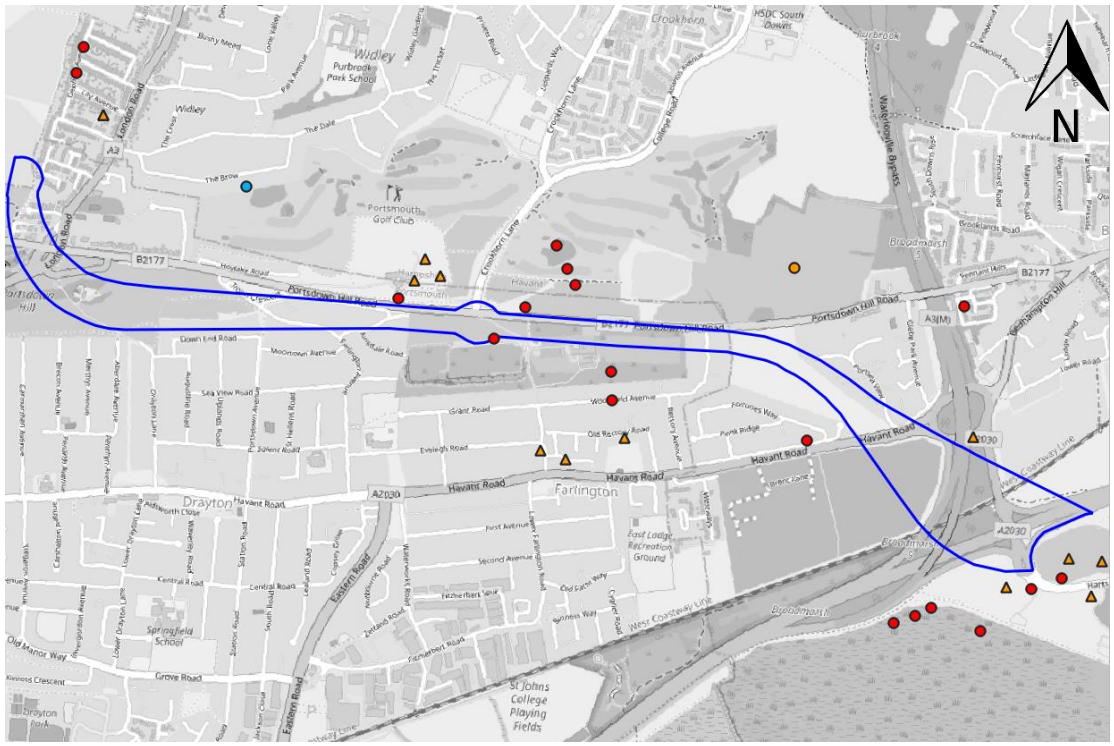
3No. HE bombs fell on the foreshore near Forty Acre Farm, within approximately 0.3km south-southwest of the Site.

Figure 6 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R1-MAP01-A.

Figure 6 Compiled bomb impact map for the vicinity of the Site

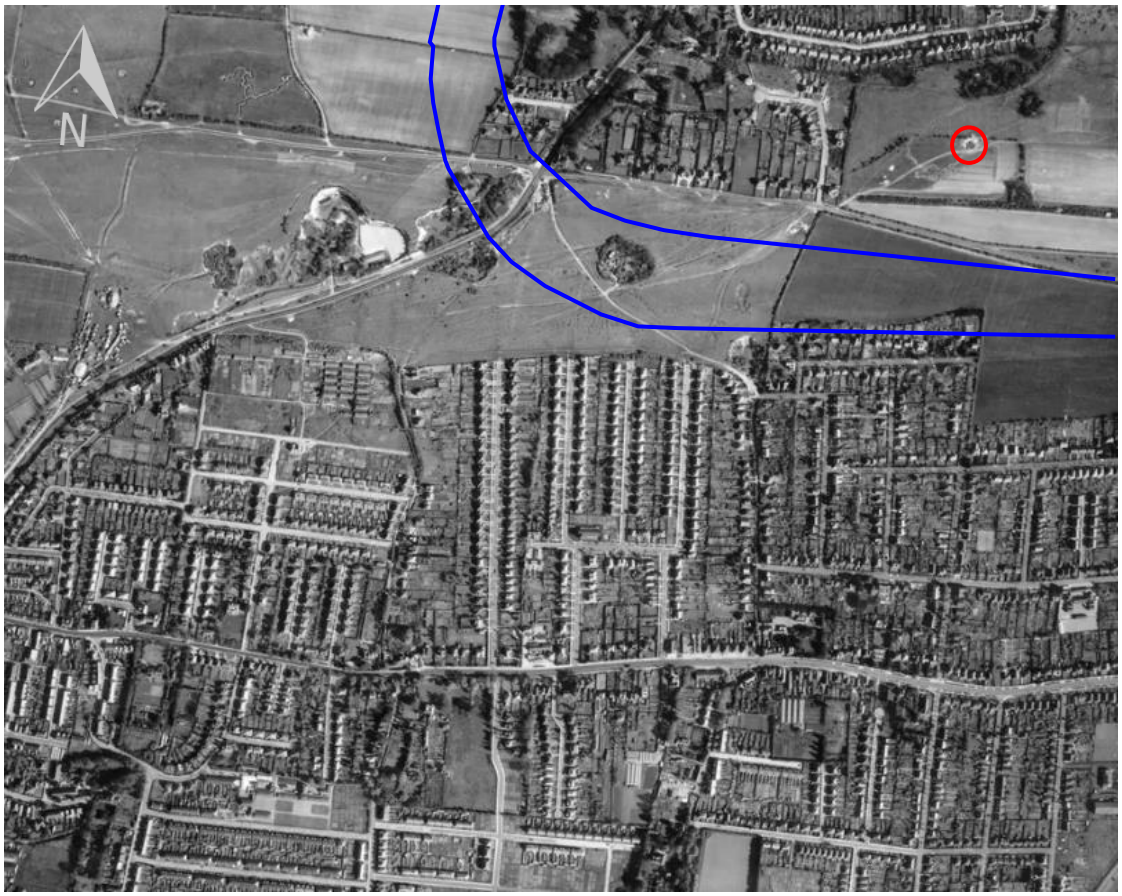


Legend	Site boundary	HE bomb	UXB
	IBs	OB	

Plate 2 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

1No. possible bomb crater has been identified to the north of the Site.

Plate 2 Aerial photograph (SU 669062), 19th April 1946



Source: Historic England *Not to Scale*

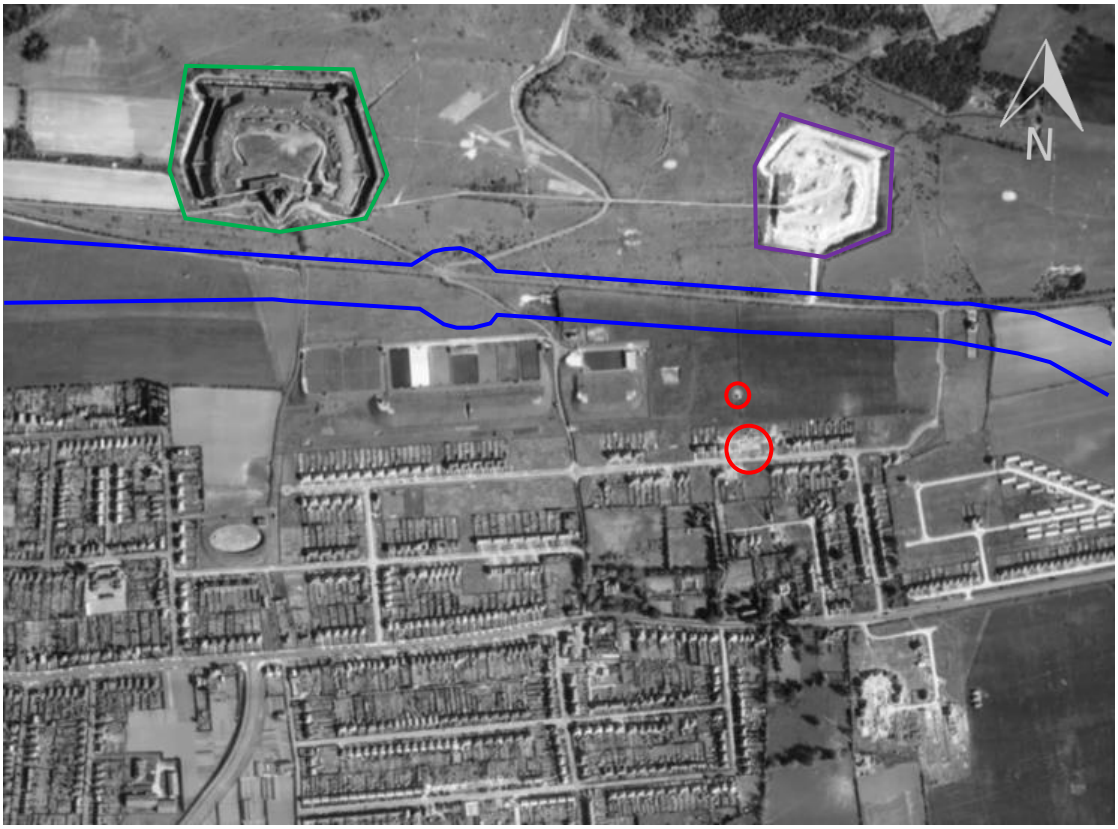
Legend	Site boundary	Possible bomb crater

Plate 2 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

Some possible bomb damage has been identified to the south of the Site.

Fort Purbrook and Farlington Redoubt have been highlighted (see Section 3.1.1).

Plate 3 Aerial photograph (SU 682062), 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb damage
	Fort Purbrook	Farlington Redoubt

Plate 4 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site.

It should be noted that in marshland and mudflats, bomb impact features are often difficult to distinguish due to deeper penetration and the development of camouflets.

Plate 4 Aerial photograph (SU 697055), 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

Records have been found indicating that at least 6No. HE bombs fell in the immediate vicinity of the eastern part of the Site during WWII. Langstone Harbour, in the vicinity of the Site, was heavily attacked over multiple raids, with at least 300No. HE bombs fall in the wider harbour area (see also Appendix 5).

Given the number and intensity of raids, it is considered possible that an UXB may have fallen unnoticed on the eastern part of the Site, which comprised marshland and tidal mudflats.

No evidence of significant bombing has been identified on the remainder of the Site.

[redacted] is considered to provide a possible source of UXO hazard to the eastern part of the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the landward part of the Site is understood to consist of Made Ground and topsoil, overlying the Spetisbury Chalk Member and the Portsdown and Newhaven Chalk Formations.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of topsoil (modelled as soft clay) overlying more than 20m of weak rock.

Table 2 Estimated average maximum bomb penetration depths (landward part of the Site)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	2.5m
	250kg	4.0m
	500kg	6.5m

The WWII geology of the parts of the Site comprising marshland is understood to consist of silt, sand, and gravel, and river terrace and raised marine deposits, overlying chalk of the Lewes Nodular, Seaford, Newhaven, Culver, and Portsdown Chalk Formations.

Table 3 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of silt (modelled as wet clay), over 3m of soft clay, over 2m of gravel, overlying more than 20m of weak rock.

Table 3 Estimated average maximum bomb penetration depths (marshland part of the Site)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	5.0m
	250kg	6.0m
	500kg	8.5m

Where Made Ground was present, the estimated average bomb penetration depths are likely to be less than the ones given in Tables 2 and 3.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Tables 2 and 3 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ^{o} to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

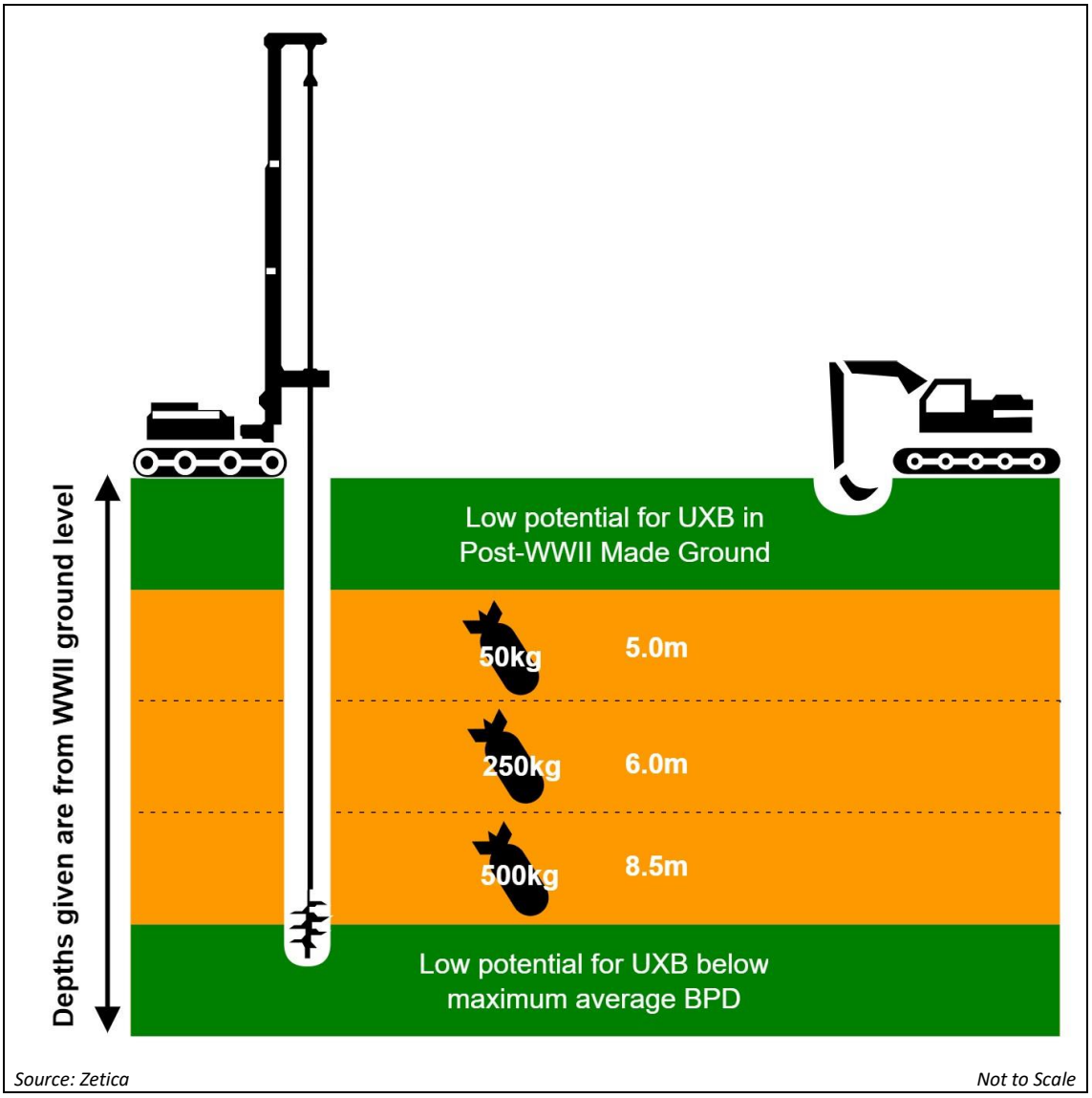
Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

Figure 7 demonstrates the potential burial setting for a UXB on the eastern part of the Site, based on the anticipated ground conditions and average maximum bomb penetration depth.

Figure 7 Potential burial setting of UXB on the Site



Source: Zetica *Not to Scale*

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office (WO) statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

WO statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

Records have been found indicating that at least 6No. HE bombs fell in the immediate vicinity of the eastern part of the Site during WWII. Langstone Harbour, in the vicinity of the Site, was heavily attacked on multiple occasions.

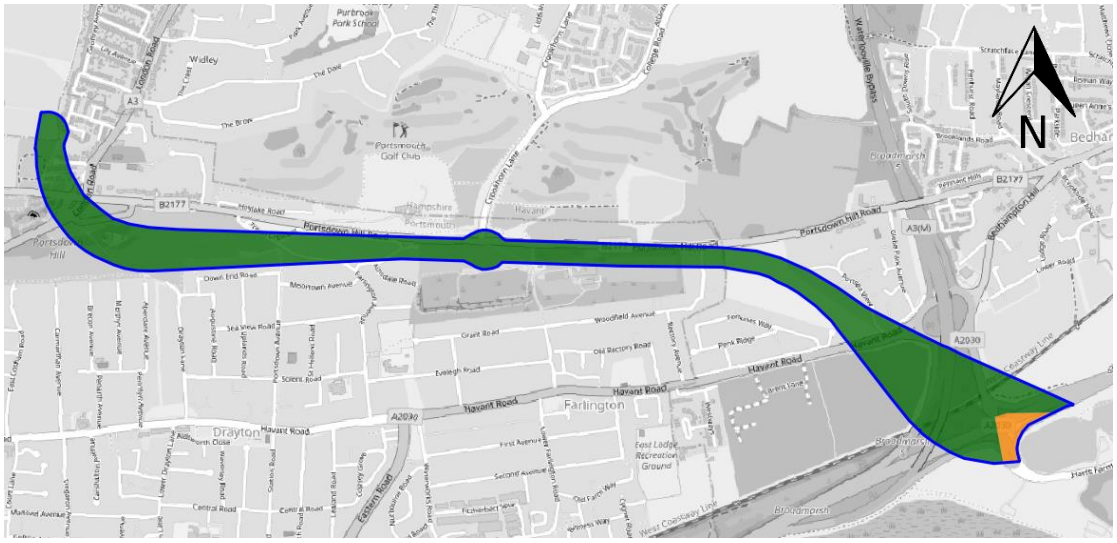
Given the number and intensity of raids, it is considered possible that an UXB may have fallen unnoticed on the eastern part of the Site, which comprised marshland and tidal mudflats. This part of the Site is assigned a moderate UXO hazard level.

No further bombing and no other significant sources of UXO hazard have been identified on the remainder of the Site, which is assigned a low UXO hazard level.

It is considered that the UXO hazard level on the Site can be zoned from low to moderate, as shown in Figure 8.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R11-MAP01-A.

Figure 8 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 4.

Table 4 UXO risk assessment for the Site

Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Moderate	UXB	Excavations	3	2	6	3	5	15	Moderate
		HDD	2	3	6	3	4	12	Moderate
	Other UXO	Excavations	1	1	1	1	4	4	Low
		HDD	1	1	1	1	3	3	Low
Low	UXB	Excavations	1	1	1	1	5	5	Low
		HDD	1	1	1	1	4	4	Low
	Other UXO	Excavations	1	1	1	1	4	4	Low
		HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood									
HDD = Horizontal Directional Drilling									

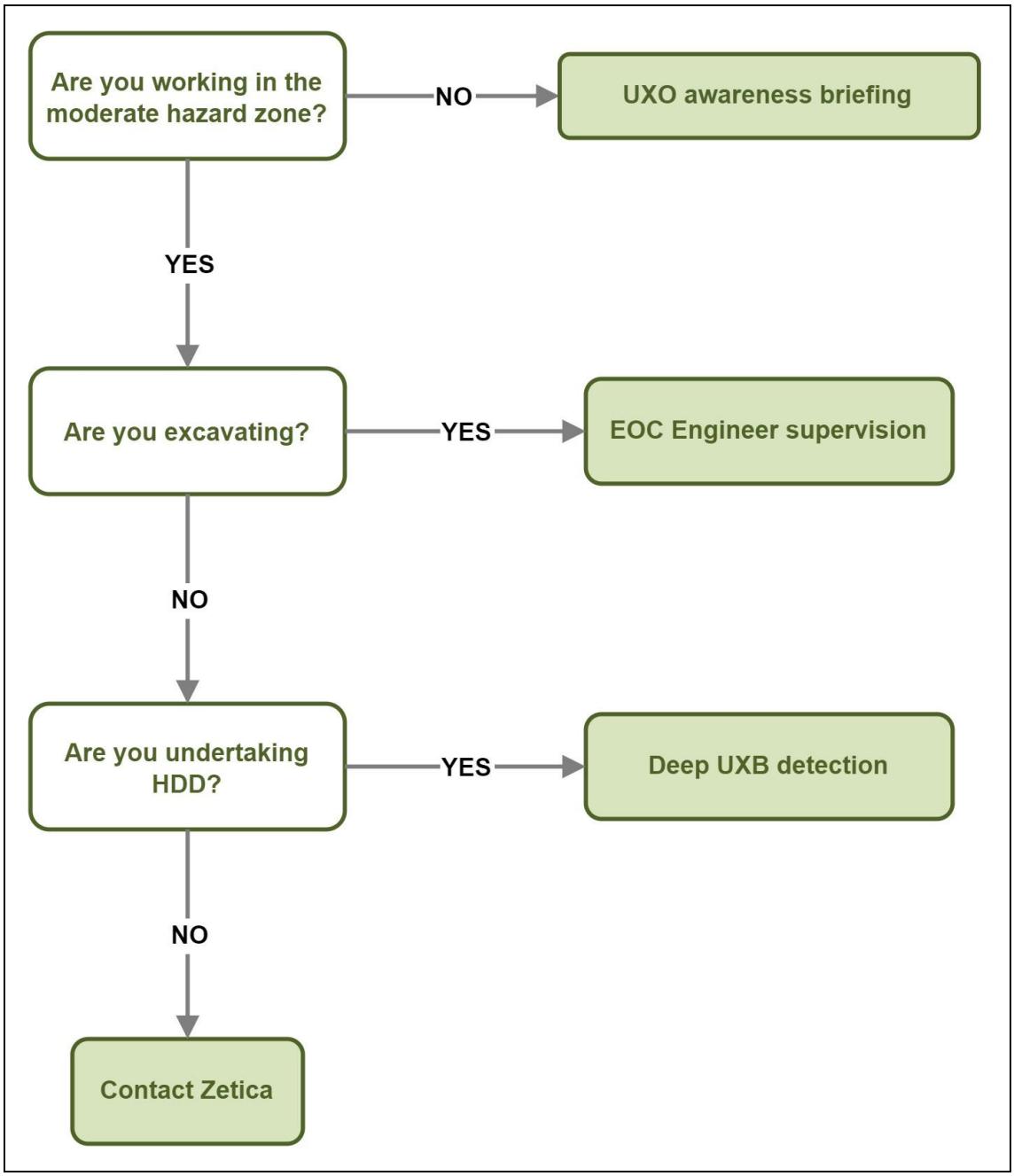
8 RISK MITIGATION PLAN

Key findings: Potential hazard from UXBs on the eastern part of the Site.

Key actions: EOC engineer supervision is required for excavations and deep UXB detection is required to clear HDD routes within the moderate hazard zone. An UXO awareness briefing is recommended for all staff involved in excavations.

Figure 9 outlines the recommended steps to reduce the UXO risk to As Low As Reasonably Practicable (ALARP).

Figure 9 Recommended risk mitigation plan for the Site



8.1 UXO risk summary

Table 5 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 5 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**
Excavations		**EOC Engineer supervision –** to ensure safety and minimise delays, EOC Engineer supervision is recommended.
HDD		**Deep UXB detection** – an intrusive magnetometer survey should be undertaken until either maximum bomb penetration depth or maximum drilling depth is reached.

In summary, it is recommended that excavations within the moderate hazard zone are supervised by an EOC Engineer.

To clear the proposed HDD route, we recommend that deep UXB detection is undertaken.

An UXO awareness briefing is recommended for all staff involved in excavations.

8.2 Risk mitigation techniques

8.2.1 EOC Engineer supervision

Given the amount of Made Ground on the Site, the effectiveness of a non-intrusive UXO detection survey is likely to be reduced.

It is considered more practical for an EOC Engineer to attend site and supervise during excavation works if required.

The EOC Engineer will carry out a visual assessment on any suspect items uncovered during the excavation works and classify them as potential UXO or other material.

If an item of UXO is uncovered, the EOC Engineer will liaise with the authorities and arrange for its disposal as appropriate.

8.2.2 Deep UXB detection

To clear the HDD route of potential UXB, an intrusive magnetometer survey should be undertaken.

The survey should be carried out to either the maximum bomb penetration depth or maximum drilling depth, whichever is shallower.

MagCone is a CPT-based system that facilitates the pushing of a magnetometer into the ground along the proposed HDD route.

If working within a road environment, the predrilling of the hardstanding may be required.

MagCone is suitable for cohesive/loose soils and has a much higher speed of operation compared to MagDrill. It should be noted that where dense soils or buried obstructions are encountered, MagCone is unlikely to be able to penetrate to the required depth.

Typical radius of detection should be assumed as approximately 1.0m for a 50kg UXB until site conditions are confirmed. A 2m centre spacing is recommended along the proposed route.

Assuming no objects comparable to the UXB detection range are identified, then the HDD route can be considered clear of UXB.

If any ferrous anomalies are identified along the HDD route, then it may need to be relocated or the anomaly investigated.

It should be noted that in Made Ground or close to buried/adjacent structures, effective UXB detection is compromised due to geophysical noise.

A clearance report should be issued on completion of the site works.

8.2.3 UXO awareness briefing

It is recommended that all staff involved in excavation works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or have any comments, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

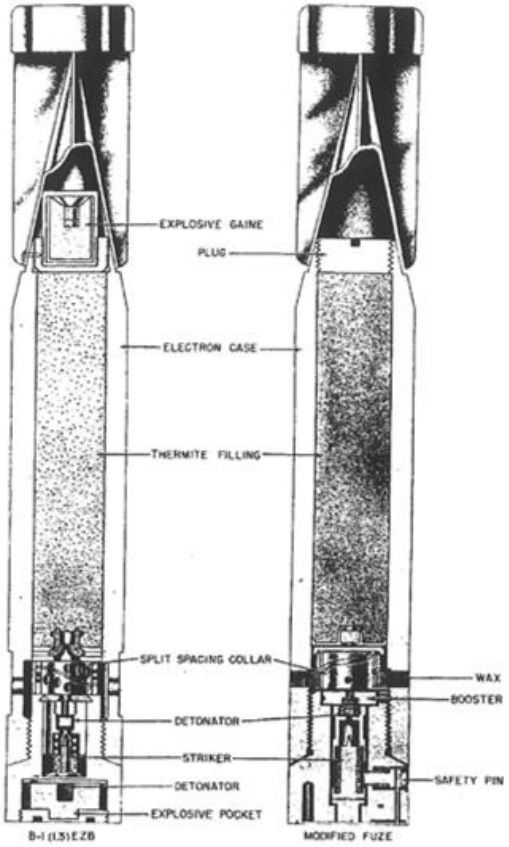
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 1kg

Variants	6
Body Dimensions	350mm x 50mm (13.8" x 1.97")
Weight	1kg & 1.3kg (2.2lbs & 2.86lbs)
Charge Weight	8 -15 gm (0.28 – 0.53 oz) in models with Nitropenta explosive. No charge in B-1 & B-1.3 E types.
Fuze	Impact fuze with safety plug
Composition	Sheet steel
Description	The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze. The after body is tapered to receive the sheet metal, three-fined drum-shrouded tail assembly. The bomb is unpainted magnesium; the tail is dark green.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations.



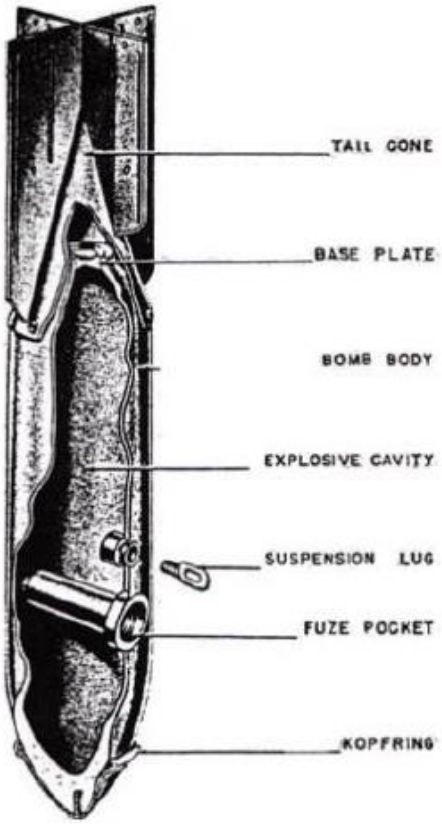




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



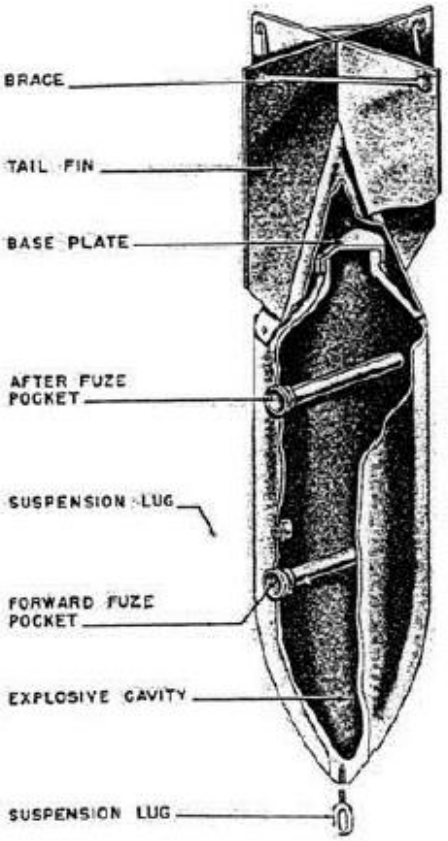




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



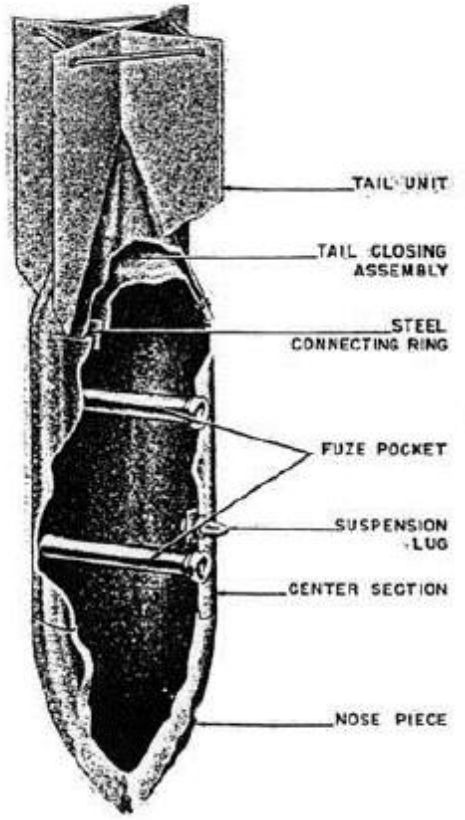




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



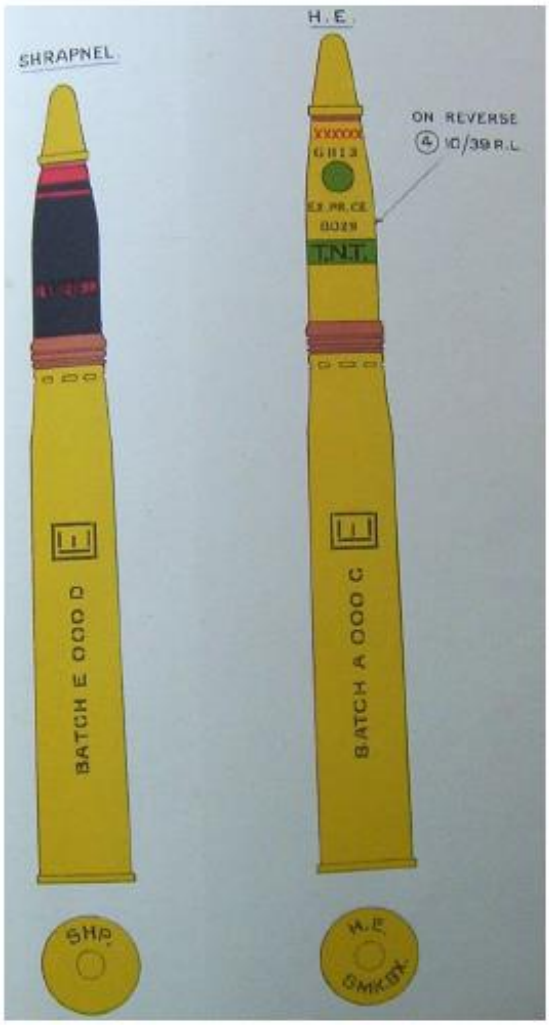




Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.



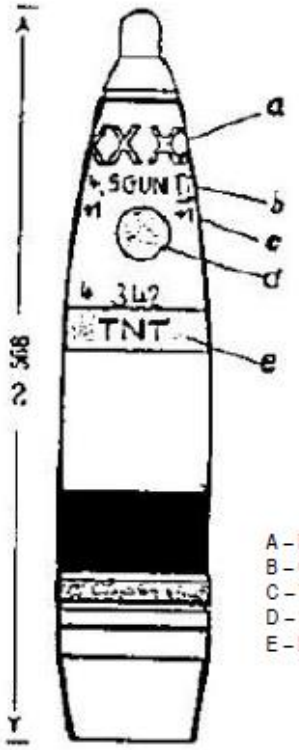




Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants	-
Body Dimensions	114mm x 566mm (4.5" x 21.9")
Weight	24.9kg (55lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.
Function	Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

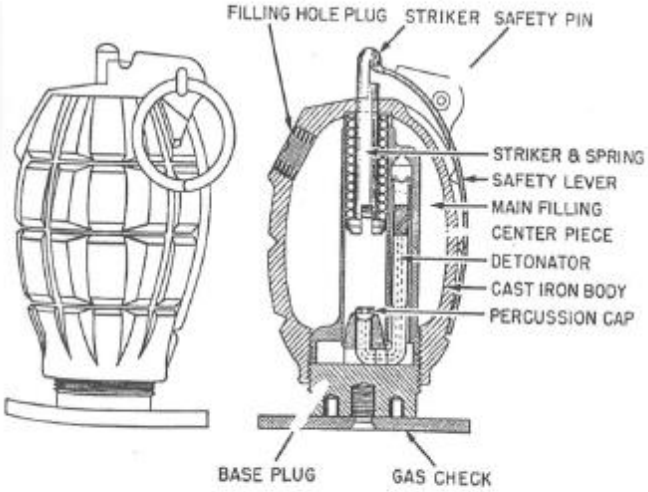
SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.





Information Data Sheet

Category Grenades (British)
Type No. 36 Hand Grenade ('Mills Bomb')



Variants	-	**Dimensions**	101.6mm x 61mm (4" x 2.4")
Weight	2 lbs	**Delay**	4 seconds
Filling	Baratol	**Material**	Cast Iron

Description Lemon-shaped, cast-iron body filled with high explosive. Three holes in the body; one in the base for priming, one near the top for filling; one on the top holding striker.

Function Used as a defence against enemy personnel.





Information Data Sheet

Category Grenades (British)
Type No. 76 Self-Igniting Phosphorus Grenade

Variants -

Dimensions 152.4mm x 63.5mm (6" x 2.5")

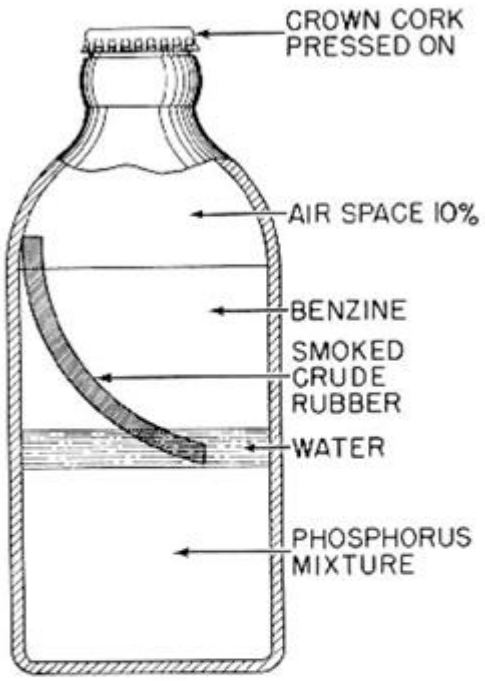
Weight 1lb

Fuze Self-igniting upon breakage

Material Glass

Description Glass bottle filled with white phosphorus, benzene, water and crude rubber.

Function Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.

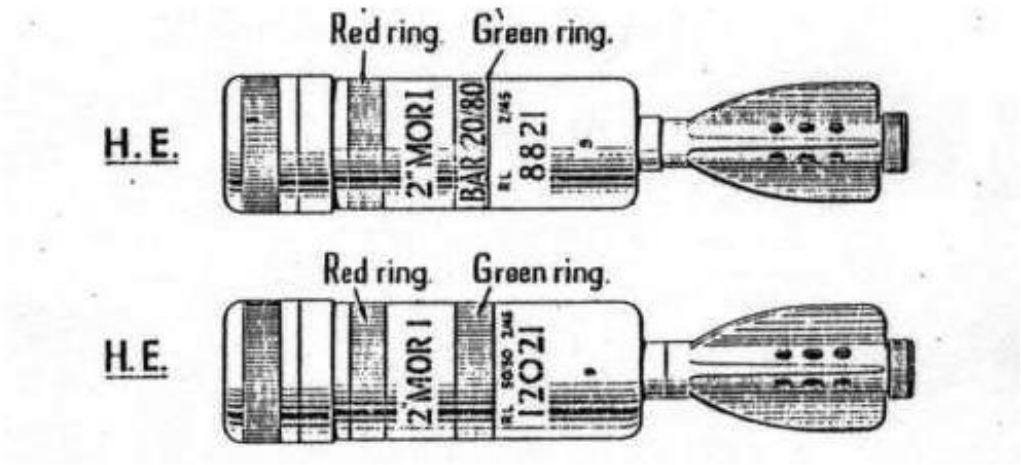






Information Data Sheet

Category Mortar (British)
Type 2-Inch Mortar Bomb



Variants	14	**Length**	11.4" x 2"
Weight	2.5lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	50.8mm (2.0 inches)	**Rate of Fire**	8 rounds per minute

Description Pear-shaped steel body with 6 or 8 vanes. Originally painted buff yellow or dark grey. Filled with c TNT, granular TNT or powdered Amatol. Also smoke, illumination and practice versions.

Function Small enough to be carried by one man, with a range limited to 500 yards, the 2" mortar was usec an anti-personnel role.





Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 Bombing Decoys

Information Data Sheet

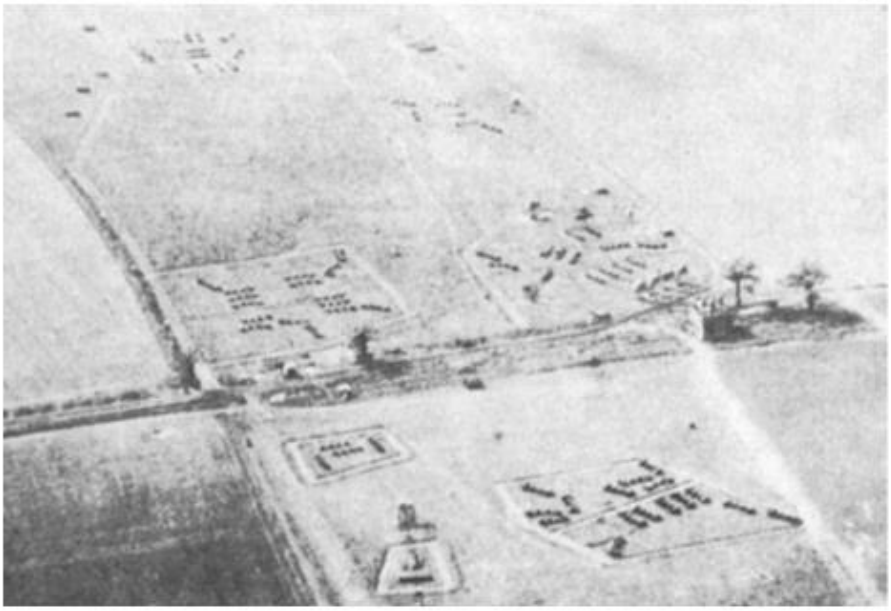
Category Bombing Decoys

Description:

Bombing decoys were developed between 1940 and 1941, designed to create false bombing targets realistic enough to divert enemy aircraft away from the authentic ones. The decoy system proved successful in many areas of the UK, with at least 5% of the total weight of bombs drawn away from their intended targets. Approximately 792No. static bombing decoys were built at 593No. locations across the UK.

Several different types of decoy existed:

- Dummy airfields for daytime ('K sites') and night-time ('Q sites'). These would include dummy aircraft, and landing lights and flare paths to simulate airfield lighting.
- Diversionary fires on airfields ('QF sites'), petroleum depots ('P sites'), and major towns and cities ('Starfish (SF) sites'). These would comprise frames of combustible material that would be lit to simulate successful bombing raids.
- Simulated urban lighting ('QL sites').
- Dummy Heavy Anti-Aircraft (HAA) batteries, factories, and buildings ('C series').
- Mobile decoys representing 'hards' for troops embarkation and tanks ('MQL sites')



SF decoy site

Hazard:

By their nature, bombing decoys provide a potential hazard from Unexploded Bombs (UXB), both within the decoy boundary and in the surrounding areas. Many decoys were established on greenfield sites, meaning seemingly innocuous fields may have a potential UXB hazard.

The most important thing to understand is if a bombing decoy was successful, as whilst many were attacked, some were not and therefore will not constitute an UXB hazard.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 [redacted] incident list

30th September 1940

1No. HE bomb fell on the Bedhampton Chalk Pit, Portsdown Hill Road, approximately 0.4km north-northeast of the Site.

11th November 1940

Several IBs fell on open ground south of Manor Farm, Bedhampton, approximately 40m north-northeast of the Site.

19th November 1940

1No. HE bomb fell on open ground adjacent to the Portsmouth Water Works Co. Upper Reservoirs, Farlington, adjacent to the Site.

1No. HE bomb fell on open ground off Crookhorn Lane, approximately 30m north of the Site.

1No. HE bomb fell on the junction of Grant Road and Farlington Road, approximately 0.2km south of the Site.

1No. HE bomb fell on Lower Farlington Road, approximately 0.2km south of the Site.

5th December 1940

HE bombs (number unspecified) fell in Langstone Harbour, within approximately 0.8km southeast of the Site.

15th January 1941

1No. Delayed Action Bomb (DAB) fell in Langstone Harbour, south of Bedhampton Mill, within approximately 0.5km southeast of the Site.

24th February 1941

1No. HE bomb fell on open ground at Widley Farm, approximately 0.5km northwest of the Site. This was recorded as an UXB.

10th March 1941

Several IBs fell on Widley and Purbrook, within approximately 0.3km northeast of the Site.

8th April 1941

1No. HE bomb fell on open ground between Military Road and Fort Purbrook, approximately 20m north of the Site.

1No. HE bomb fell on open ground off Farlington Road, approximately 0.1km south of the Site.

11th April 1941

8No. HE bombs fell in Langstone Harbour, between Farlington and Langstone Bridge, within approximately 0.5km southeast of the Site.

17 – 18thApril 1941

2No. HE bombs fell on open ground north of Portsdown Hill Road, Bedhampton, within approximately 0.1km north of the Site.

1No. HE bomb fell on the garden of 74 The Brow, Purbrook, approximately 0.3km north of the Site. This was recorded as an UXB.

4th May 1941

Several IBs fell on Farlington, within approximately 0.3km south of the Site.

7th May 1941

Several IBs fell on Farlington, within approximately 0.3km south of the Site.

1st June 1941

2No. HE bombs fell on Geoffrey Avenue, Widley, approximately 0.3km north-northeast of the Site.

5th June 1941

1No. HE bomb fell on the north side of Langstone Harbour, south of Bedhampton, approximately 0.2km south of the Site.

2No. HE bombs fell on the north side of Portsdown Hill, near the Farlington Redoubt, approximately 0.4km north of the Site.

9th June 1941

2No. HE bombs fell in Langstone Harbour, near Binness Island, within approximately 0.8km south of the Site.

26th June 1941

2No. Parachute Mines (PMs) fell on Widley Farm, Southwick, approximately 0.3km north-northwest of the Site. These were recorded as Unexploded PMs (UXPMs).

8th March 1943

1No. HE bomb fell on the Auriol Estate, approximately 0.1km southwest of the Site.

1No. Oil Bomb (OB) fell on Portsdown Hill, Bedhampton, approximately 0.2km north-northeast of the Site.

15th – 16th August 1943

2No. HE bombs fell in the sea at Broad Marsh, within approximately 60m south of the Site.

Several IBs fell on Broad Marsh, within approximately 50m south of the Site.

Several IBs fell on Fort Purbrook, within approximately 80m north of the Site.

3No. HE bombs fell on the foreshore near Forty Acre Farm, within approximately 0.3km south-southwest of the Site.

Approximately 40No. HE bombs fell in Langstone Harbour, within approximately 0.8km southeast of the Site.

15th May 1944

At least 22No. HE bombs fell in Langstone Harbour, within approximately 0.8km southeast of the Site.

Appendix 6 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Easthope W G, Smitten City: The Story of Portsmouth under Blitz, 1981

Morris J, German Air Raids on Britain 1914-1918, 1993

Leete J, In Time of War: Hampshire, 2006

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 7 General Notes

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2. The report should not be used by third parties without prior consultation with Zetica Ltd. The copyright for this report remains with Zetica Ltd.
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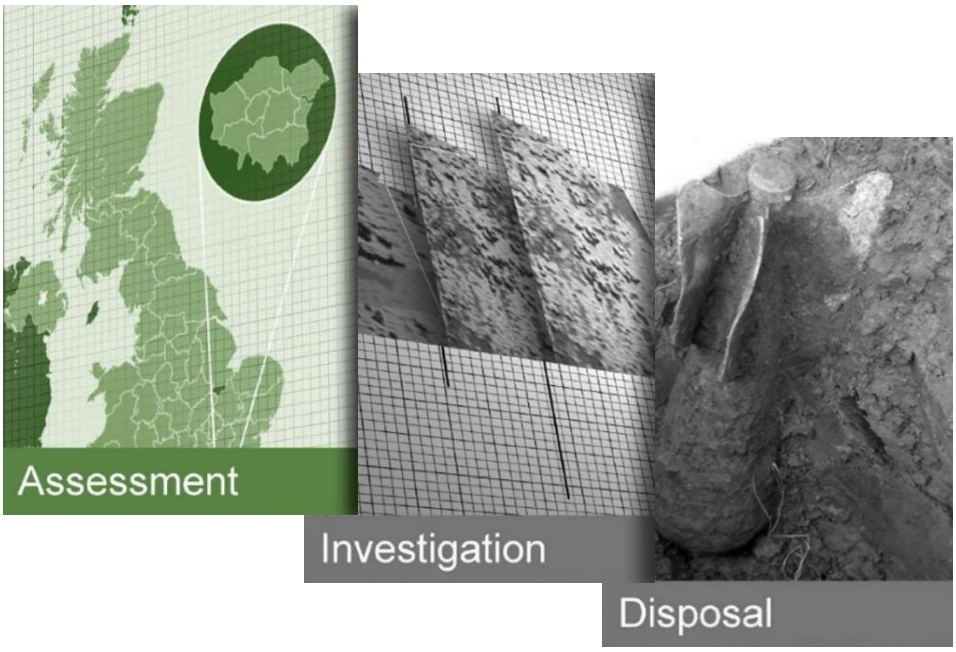
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R10**
Revision	**A**
Project Title	**E Site**
Client	**Southern Water**
Date	**3rd April 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: UXO awareness briefing is recommended for all staff involved in excavations.

UXO hazard assessment

Between the 1860s and 1950s, the eastern part of the Site encroached on the Portsdown Military Lands. No significant sources of UXO hazard associated with the Portsdown Military Lands have been identified on the Site.

Additionally, records have been found indicating that 2No. High Explosive (HE) bombs and several Incendiary Bombs (IBs) fell on the Site and exploded during World War Two (WWII).

No further bombing and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced asFigure 5 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R10-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

The main findings of the report are summarised below.

- During the 1860s the Portsdown Military Lands were established on an area encroaching onto the eastern part of the Site. The lands were used to establish a series of defensive Palmerston Forts overlooking Portsmouth. The nearest was Fort Widley, approximately 0.2km southwest of the Site.
- During World War One (WWI) and WWII Fort Widley was used primarily as barrack accommodation and a local headquarters (HQ).

- During WWII several anti-invasion defences were established on the Portsdown Military Lands, including 1No. slit trench on the Site. Several mock invasion exercises were undertaken in the vicinity of the Site.
- On the 6th November 1940, 1No. Hawker Hurricane I (V7602) fighter aircraft crashed on the Site. The wreckage was excavated and subsequently removed after WWII.
- During WWII the main strategic targets in the vicinity of the Site included military barracks and depots, public utilities, and anti-invasion defences.
- Records have been found indicating that 2No. HE bombs and several IBs fell on the Site during WWII and exploded. No further records of bombing on the Site have been found.
- There were 20No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.
- After WWII, the Portsdown Military Lands were de-requisitioned. Fort Widley was sold to Portsmouth City Council in 1972 and is currently home to an equestrian centre.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

What do I do next?

If you require a quote for an awareness briefing or have any comments, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS data

P14032-24-R10-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARE	Admiralty Research Establishment
ARP	Air Raid Precaution
AT	Anti-Tank
AXO	Abandoned Explosive Ordnance
BDU	Bomb Disposal Unit
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
DSTL	Defence Science and Technology Laboratory
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HMS	His Majesty's Ship
IB	Incendiary Bomb
IWM	Imperial War Museum
KBB	Kite Balloon Base
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
PoW	Prisoner of War
PTP	Portsdown Technology Park
RA	Royal Artillery
RAF	Royal Air Force
RBL	Rifled Breech-Loading
RE	Royal Engineers
RGA	Royal Garrison Artillery
RML	Rifled Muzzle-Loading
RN	Royal Navy
SBBL	Smooth Bore Breech-Loading
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route of approximately 7.2km between Boarhunt and Widley, Portsmouth, Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Portsmouth City Council, The Portsmouth History Centre and Hampshire Record Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

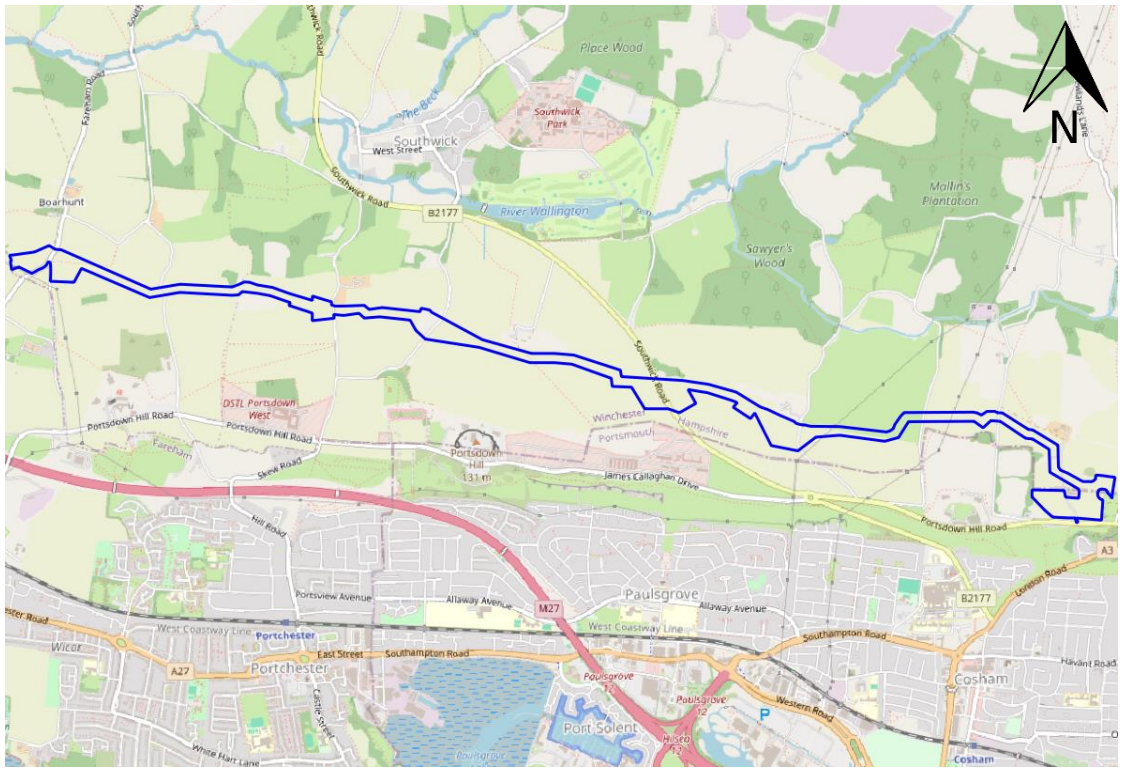
2.1 Site location

The Site commences at Boarhunt at Ordnance Survey National Grid Reference (OSNGR) SU 601080 and terminates near Widely at OSNGR SU 666066. It is located approximately 4.3km north-northeast of central Portsmouth.

The Site comprises open ground, crossed by several roadways. It is bounded to the north and south by open ground and residential buildings, and to the east and west by open ground.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Portsdown Military Lands

Between the 1860s and 1950s the Portsdown Military Lands encroached on the eastern part of the Site. A brief history is provided below.

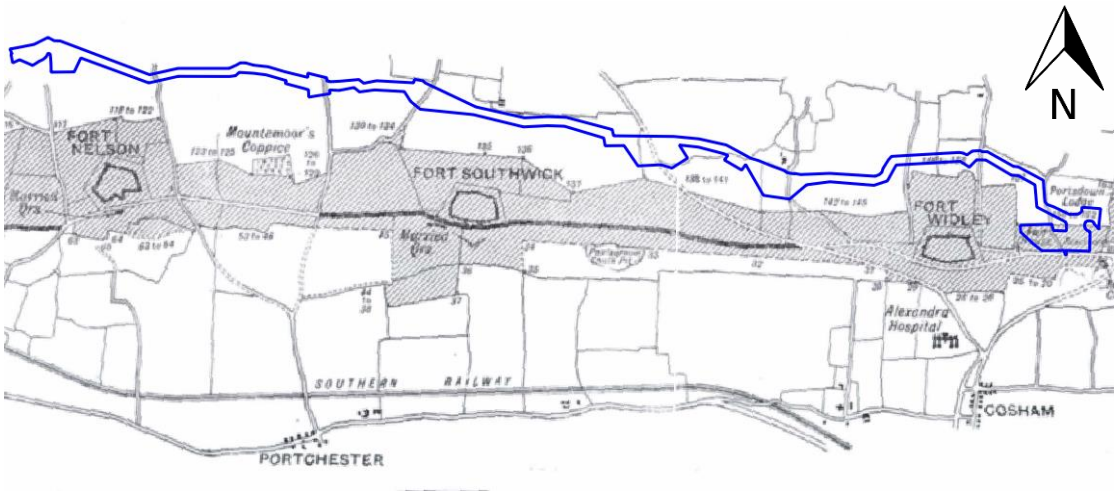
Pre-WWI

In 1861 the War Office (WO) requisitioned an area of land encompassing Portsdown Hill, encroaching on the eastern part of the Site.

Designated as the Portsdown Military Lands, it was used to establish a series of defensive fortifications overlooking Portsmouth, known as Palmerston Forts. Designed to protect Portsmouth and its important naval dockyard from a possible inland attack, 3No. forts were constructed in the vicinity of the Site.

The nearest was Fort Widley (SU 656064), approximately 0.2km southwest of the Site. Fort Nelson and Fort Southwick were also established within approximately 0.4km south of the Site, as shown on Figure 2 below. The 3No. forts have been annotated.

Figure 2 Plan of the Portsdown Military Lands, 1928



Source: MoD *Not to Scale*

Legend	Site boundary	Portsdown Military Lands

The Palmerston Forts were of polygonal design and comprised multiple heavy gun batteries facing inland. They had accompanying storage magazines and accommodation facilities for officers and other ranks.

By 1893 Fort Widley was armed with 10No. 7” rifled breech-loading (RBL) guns, 4No. 64-pounder (pdr) rifled muzzle-loading (RML) guns, 4No. 20-pdr RBL guns, 5No. 6.6" Howitzers and 8No. 32-pdr smooth bore breech-loading (SBBL) guns.

By 1907 the Palmerston Forts had been disarmed.

WWI

During WWI the Palmerston Forts remained in use primarily as barrack accommodation. They were also incorporated into regional Anti-Aircraft (AA) defences (see Section 3.2.1).

Records indicate that Fort Widley was occupied by the Ox and Bucks Light Infantry, tasked with defending the overland approaches to Portsmouth.

Fort Southwick was used to train soldiers on how to capture and hold enemy fortifications, involving mock attacks over the ramparts.

Interwar

Between 1919 and 1922 Fort Southwick was used as a demobilisation centre for troops returning from overseas.

Fort Nelson and Fort Widley remained in use as military barracks for the Royal Artillery (RA).

WWII

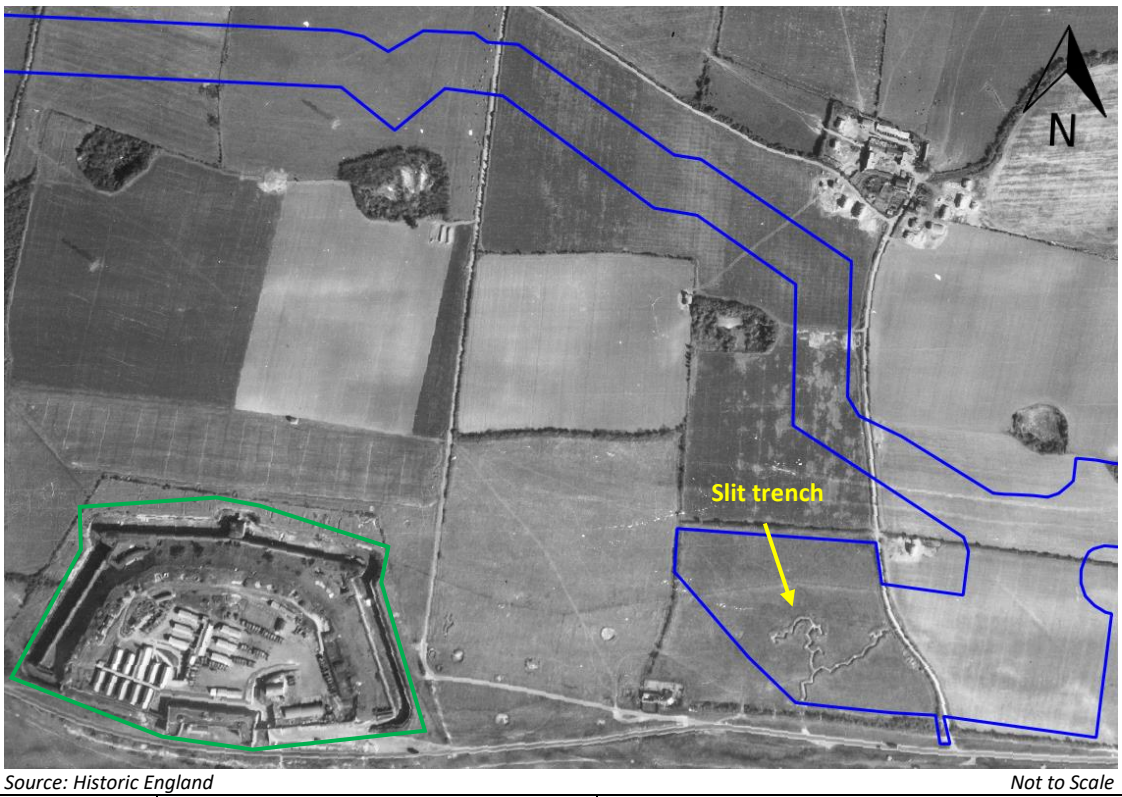
During WWII the Palmerston Forts again served as important regional military centres.

From 1940 Fort Widley served as a Fire Action Post and HQ for a Royal Engineers (RE) Bomb Disposal Unit (BDU). In 1942 it was briefly used to house German Prisoners of War (PoWs). From 1943 it served as a control centre during the build up to Operation Overlord, the allied invasion of occupied Europe.

During this period numerous anti-invasion defences were established on Portsdown Hill (see Section 3.2.2).

Plate 2 is an aerial photograph dating from 19th April 1946. 1No. slit trench has been identified on the Site. Fort Widley, approximately 0.2km southwest of the Site, has also been highlighted.

Plate 2 Aerial photograph, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Fort Widley

Records indicate that several mock invasion exercises were undertaken in the immediate vicinity of Portsdown Hill (see Section 3.2.2). No records have been found to indicate that these training activities included the use of live munitions.

Records indicate that the nearest live-fire exercises were undertaken at the Paulsgrove Chalk Pit (SU 637065), approximately 0.4km south of the Site (see Section 3.6).

Post-WWII

After WWII the majority of the Portsdown Military Lands were released for civilian use.

Fort Nelson was abandoned in the 1950s. It is now a museum for the Royal Armouries.

Fort Widley was sold to Portsmouth City Council in 1972 and is currently home to an equestrian centre.

Fort Southwick was retained by the Royal Navy (RN) as part of the Admiralty Research Establishment (ARE) until 2002, when it was sold. It is now used by a commercial car dealership.

Potential UXO Hazard

Between the 1860s and 1950s the eastern part of the Site encroached on the Portsdown Military Lands.

No records have been found to indicate that any live-fire military training took place on the Site, and no evidence of significant military training, denotated by cratering or disturbed ground, has been identified on the Site on historical aerial photography.

It should be noted that given part of the Site was located within the Portsdown Military Lands, the potential for encountering surface-level or shallow-buried UXO on the Site, whilst unlikely, cannot be totally discounted.

The Portsdown Military Lands are not considered to provide a significant source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

Details of the military defences in the vicinity of the Site are given below.

3.2.1 Anti-Aircraft (AA) guns

During WWI there were 19No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Southwick (SU 628069), approximately 0.5km south of the Site. It was armed with 1No. 18-pdr gun.

During WWII there were 20No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located near Pinsley Lodge, Southwick (SU 640075), approximately 0.2km north of the Site (see Plate 5). It was armed with 4No. 3.7" guns.

1No. HAA battery was also located Boarhunt, approximately 0.3km southwest of the Site (see Plate 4).

Additionally, records indicate that 1No. searchlight AA battery was located at Widely (SU 661067), approximately 0.1km southwest of the Site. It was occupied by the 35th Searchlight Regiment. No evidence of the battery has been identified on historical aerial photography (see Plate 2).

The nearest recorded WWII AA shell incident to the Site is described below.

27th August 1940

1No. AA shell fell on open ground to the northeast of Pigeon House Farm, within approximately 0.2km north of the Site. This was recorded as an Unexploded AA (UXAA) shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.2.3 Anti-invasion defences

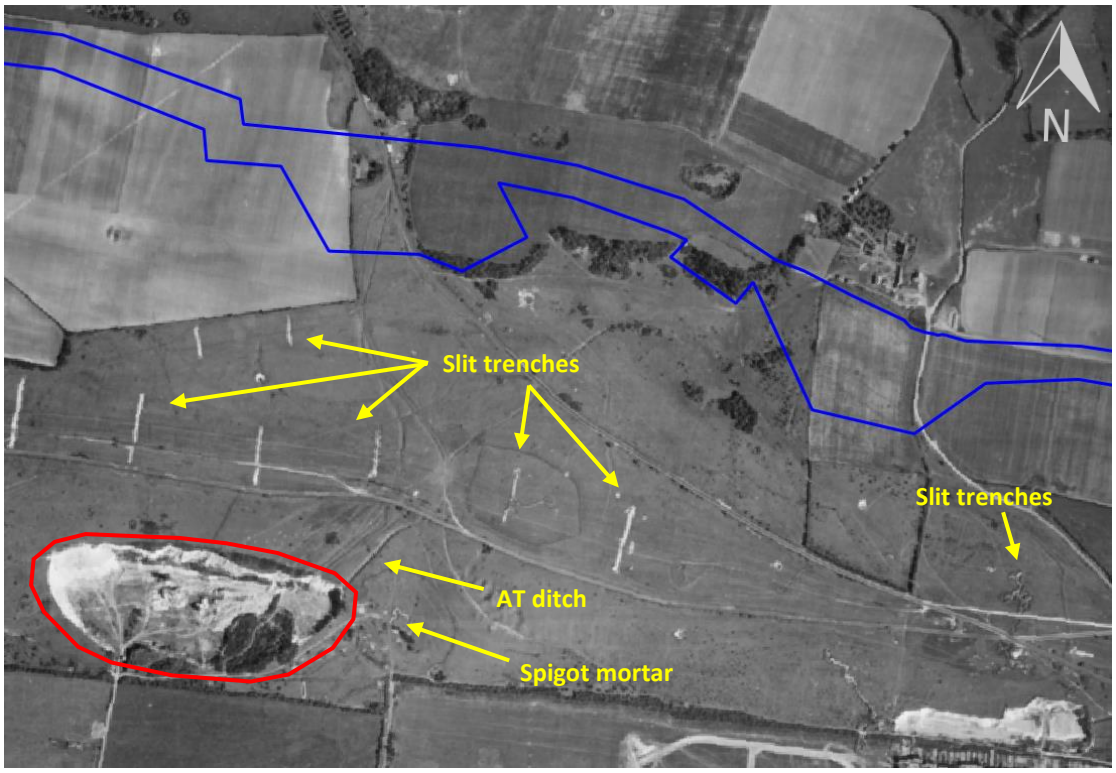
During summer 1940, the Wymering Stop Line was established along the Portsdown Hill to contain a potential German invasion. Several anti-invasion defences were established on and in the vicinity of Site.

1No. slit trench was established on the Site (see Plate 2) and 2No. pillboxes were located near Fort Widley (SU 664064), within approximately 0.1km south of the Site.

Several further slit trenches and Anti-Tank (AT) ditches were established along the Portsdown Hill Road, within approximately 0.3km south of the Site. 1No. spigot mortar was also located east of the Paulsgrove Chalk Pit (SU 639065), approximately 0.4km south of the Site.

Plate 3 is an aerial photograph dated the 19th April 1946. Several anti-invasion defences to the south of the Site and at Paulsgrove Chalk Pit (see Section 3.6) have been identified.

Plate 3 Aerial photograph showing local anti-invasion defences, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Paulsgrove Chalk Pit

Local anti-invasion defences were manned primarily by 'B' Company, 11th (Hampshire) Battalion.

Records indicate that in mid-1941, the 11th (Hampshire) Battalion undertook several mock invasion exercises in the vicinity of the Site. These involved manning anti-invasion defences along Portsdown Hill as practice for a potential enemy invasion. No records have been found indicating that these training activities took place on the Site or included the use of live munitions.

After WWII, the anti-invasion defences in the vicinity of the Site were removed.

Potential UXO Hazard

Defended positions often had associated munitions caches which may have stored Small Arms Ammunition (SAA), in addition to Land Service Ammunition (LSA) such as grenades and mortars.

These caches were typically removed at the end of WWII, although the possibility of local munitions disposal around defended positions cannot be totally discounted.

Anti-invasion defences are not considered to provide a significant source of UXO hazard to the Site.

3.2.3 Home Guard

During WWII, the 31st (Cosham) Hampshire Home Guard Battalion operated in the vicinity of the Site.

The Home Guard was responsible for patrolling local transport links and strategic targets, as well as manning regional anti-invasion defences along Portsdown Hill (see Section 3.2.2).

Records indicate that the Home Guard undertook live-fire exercises at the Paulsgrove Chalk Pit, approximately 0.4km south of the Site (see Section 3.6).

Potential UXO Hazard

It should be noted that records of Home Guard activities were rarely kept, and training activities were usually unofficial or unsanctioned.

Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often buried or dumped in ad-hoc locations.

Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

3.2.4 Bombing decoys

The nearest recorded bombing decoy was located at Farlington Marshes (SU 687041), approximately 3.1km southeast of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Flying Corps (RFC) Tipnor, approximately 3.8km south of the Site. It was established in 1917 as No. 15 Kite Balloon Base (KBB). It was closed in August 1919.

During WWII, the nearest operational airfield was Royal Air Force (RAF) Gosport, approximately 7.1km southwest of the Site. It was used for the testing of torpedo bomber aircraft and for flight training purposes.

After the end of WWII RAF Gosport was handed to the RN as shore establishment His Majesty's Ship (HMS) Siskin. It closed in 1956 and the land was subsequently redeveloped as housing.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- Aircraft Crashes

Records have been found indicating that 1No. aircraft crashed on the Site during WWII. Details are provided below.

6th November 1940

1No. Hawker Hurricane I (V7602) fighter aircraft crashed on open fields to the south of Pigeon House Farm (SU 646069), on the Site.

In October 1979, the wreckage of the Hurricane was excavated and removed by the Wealden Aviation Archaeological Group. All 8No. of the Hurricane's .303" Browning machine guns were recovered during the excavation.

Potential UXO Hazard

The aircraft crash could have resulted in SAA from the aircraft guns being scattered across a wide area. It is considered likely that most remnant SAA will have been removed during the post-WWII excavation.

SAA is not considered to provide a significant UXO hazard (see Appendix 1).

Aircraft crashes are not considered to provide a significant source of UXO hazard to the Site.

3.5 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any explosives factories, munitions depots, or munitions disposal areas on or in close proximity to the Site have been found.

3.6 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any firing ranges or military training areas on the Site have been found. The nearest is detailed below.

3.6.1 Paulsgrove Chalk Pit

During WWII, the Paulsgrove Chalk Pit (SU 637065), approximately 0.4km south of the Site, was requisitioned by the Admiralty for use as a live firing range.

The range was primarily used by Royal Marines, in addition to local Home Guard units and infantry stationed in Fort Southwick (see Sections 3.1.1 and 3.2.3). Records indicate that firing exercises used .303" SAA, anti-personnel mortars, and No. 69 hand grenades.

In 1944, the Paulsgrove Chalk Pit was used by the Royal Marines for physical training in preparation for the D-Day landings, as well as housing a secure military radio station, which was dug underground in a small tunnel system.

Records indicate that the range was thoroughly searched after each training exercise for remnant UXO.

Paulsgrove Chalk Pit is not considered to provide a source of UXO hazard to the Site.

3.7 Other military establishments

No other military establishments have been identified on the Site. The nearest are described below.

3.7.1 Portsdown West Defence Science and Technology Laboratory (DSTL)

In 2019, the DSTL established a satellite ground control station at Portsdown West (SU 616070), approximately 0.5km south of the Site.

The DSTL is an executive agency of the Ministry of Defence (MoD) and serves as a research institute to maximise the impact of science and technology for the defence and security of the UK. The Portsdown West facility is intended to support future research and innovation in space science.

Portsdown West DSTL is not considered to provide a source of UXO hazard to the Site.

3.7.1 Portsdown Technology Park (PTP)

In the 1980s, PTP was established near Fort Southwick (SU 638067) on land approximately 0.2km south the Site.

The facility is used to test and integrate communications equipment and combat software for RN warships prior to their deployment at sea.

The PTP remains in use and is currently operated by QinetiQ on behalf of the MoD.

PTP is not considered to provide a source of UXO hazard to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

Records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Portsmouth

Portsmouth was heavily bombed during WWII. There were 69No. recorded air raids on the city, with heaviest raids occurring on 24th August 1940, 10th January 1941, and 10th March 1941.

Bombing was concentrated on Portsmouth's naval base and city centre, with bombing densities dropping off in the surrounding urban and rural districts, including in the vicinity of the Site.

Military establishments in the region such as airfields, naval bases and radar stations were also specifically targeted. Records for heavy raids on many of the regions' airfields and naval bases were suppressed until after WWII.

The Site was located in an area that vulnerable to overspill from these heavy raids and was subjected to 'tip and run' raids, where bombers would jettison their unused bombs on opportunistic targets.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including military barracks and depots, public utilities, and anti-invasion defences.

The main strategic targets in the vicinity of the Site were the Palmerston Forts on Portsdown Hill (see Section 3.1.1).

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Portsmouth CB	**1,221**	**34**	**7**	**1,262**	**136.8**
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Gosport MB	587	4	10	601	97.3
Havant and Waterloo UD	375	39	9	423	35.0
Petersfield RD	457	9	19	485	8.6

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further recorded bombing incidents in the vicinity of the Site.

28th August 1940

1No. High Explosive (HE) bomb fell on open ground south of the Southwick HAA Battery, approximately 80m south-southeast of the Site. This was recorded as an UXB.

16th November 1940

4No. HE bombs fell on open ground adjacent to Fort Widley, within approximately 90m west-southwest of the Site.

24th February 1941

1No. HE bomb fell on open ground at Widley Farm, approximately 0.1km north-northeast of the Site. This was recorded as an UXB.

11th March 1941

Several IBs fell on open ground to the south of Pigeon House Farm, on the Site.

6No. HE bombs fell on open ground near Crooked Walk Lane, on and in close proximity to the Site.

12th March 1941

3No. HE bombs fell on open ground at Offwell Farm, approximately 20m south-southwest of the Site. These were recorded as UXBs.

16th April 1941

3No. HE bombs fell on Portsdown Hill, near Fort Southwick, within approximately 0.1km south of the Site.

8th July 1941

1No. HE bomb fell on open ground at New Barn Farm, approximately 20m north-northeast of the Site.

23rd May 1944

2No. 50kg HE bombs fell on Offwell Farm, approximately 0.1km northeast of the Site. These were both recorded as UXBs.

Date Unknown

400No. IBs fell on open ground near the Old Chalk Pit, Offwell Farm, potentially including on the Site.

Figures 3 and 4 are maps showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The full bomb map is also given in the accompanying P14032-24-R1-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the western part of the Site

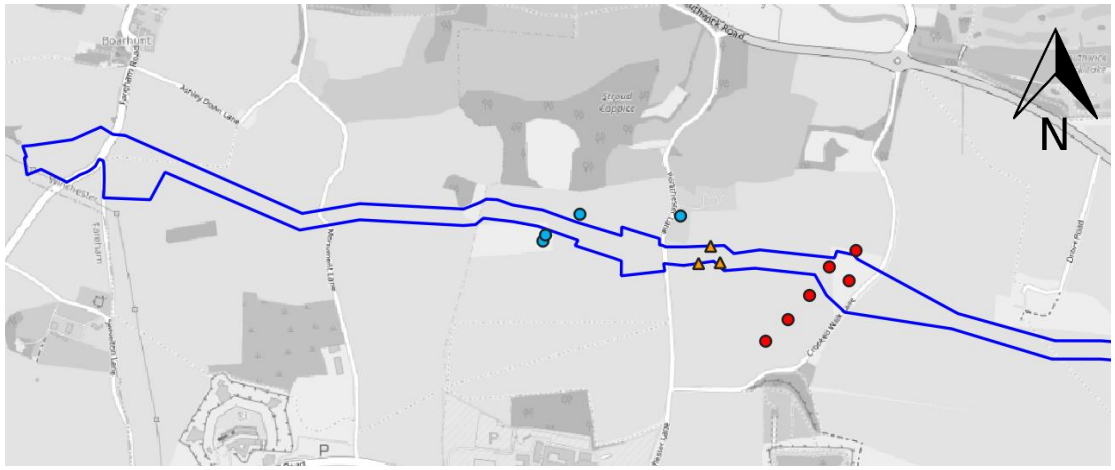
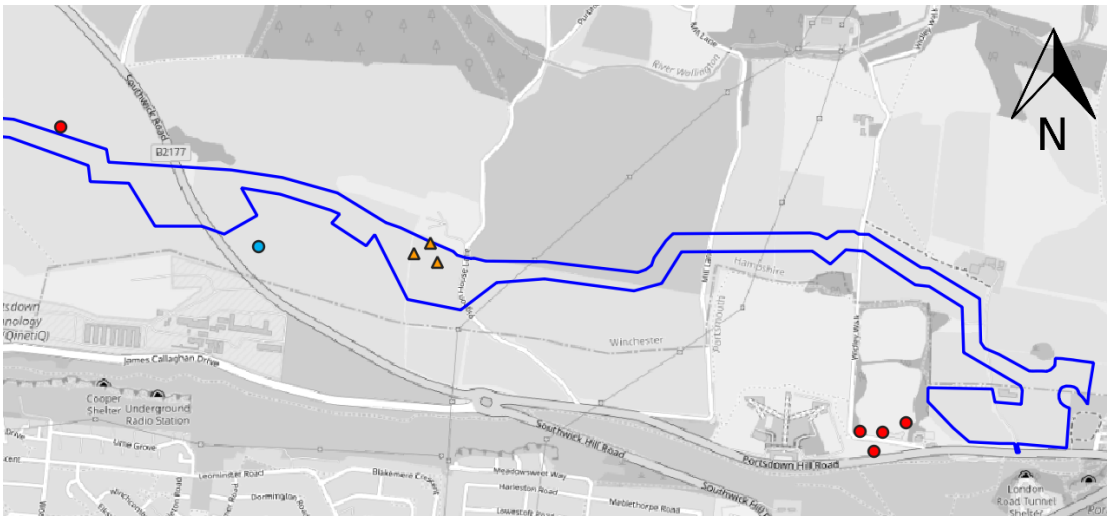


Figure 4 Compiled bomb impact map for the vicinity of the eastern part of the Site



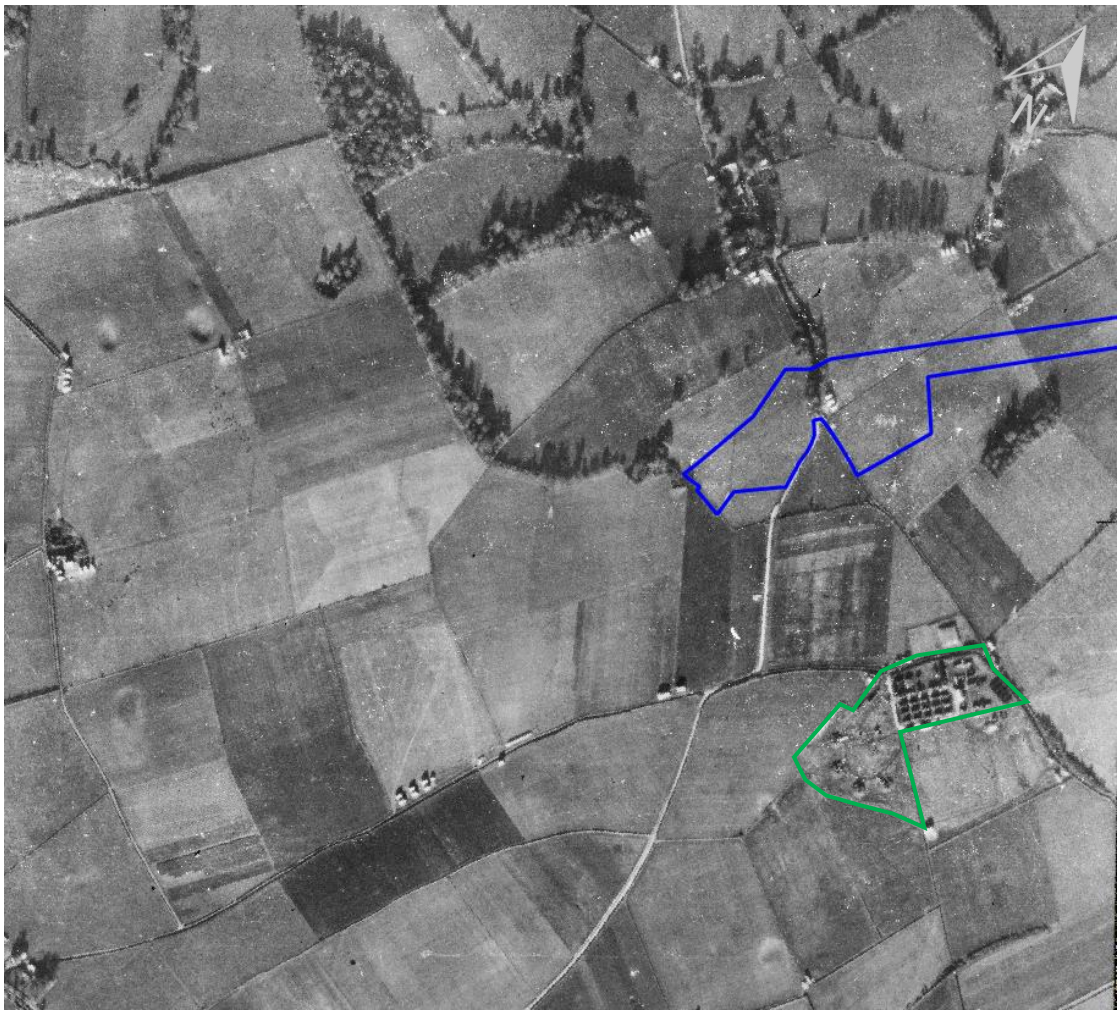
Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB	IBs

Plate 4 is an aerial photograph dated the 4th November 1946. No bomb damage or cratering has been identified on or in the vicinity of the Site.

The Boarhunt HAA battery has been identified (see Section 3.2.1).

Plate 4 Aerial photograph (SU 601080), 4th November 1946



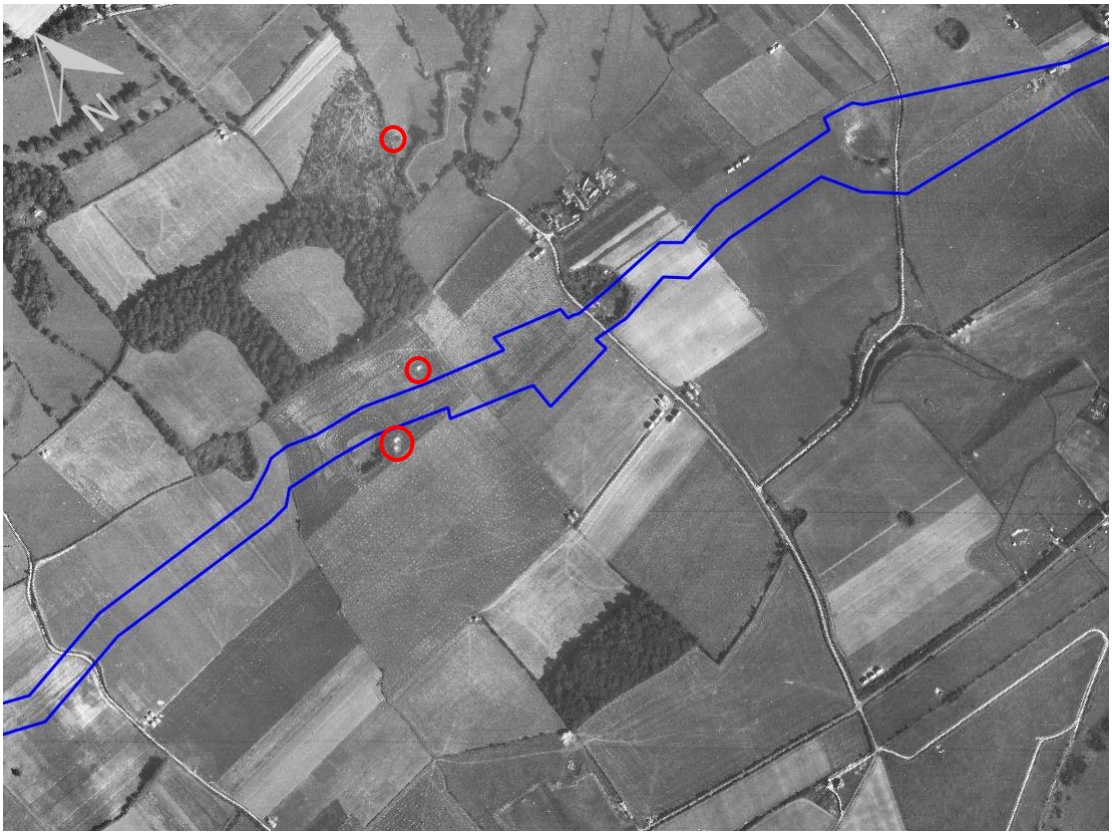
Source: Historic England *Not to Scale*

Legend	Site boundary	Boarhunt HAA battery

Plate 5 is an aerial photograph dated the 7th October 1946. No bomb damage or cratering has been identified on the Site.

Some possible bomb cratering has been identified adjacent and to the north of the Site.

Plate 5 Aerial photograph (SU 618077), 7th October 1946



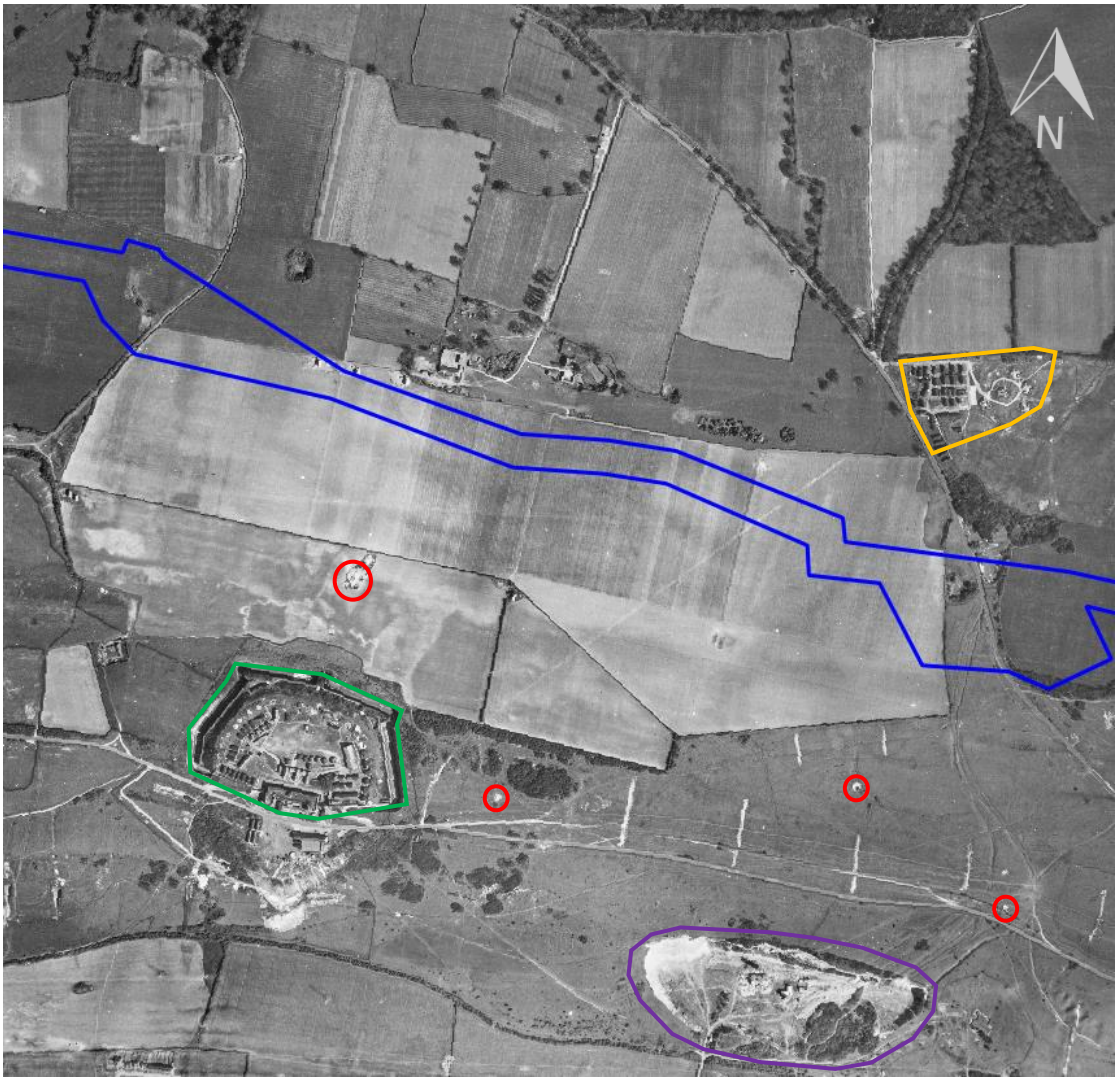
Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb cratering

Plate 6 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site. Some possible bomb cratering can be seen to the south of the Site.

Fort Southwick, the Paulsgrove Chalk Pit, and the Southwick HAA battery have been identified (see Section 3).

Plate 6 Aerial photograph (SU 633074), 19th April 1946



Source: Historic England *Not to Scale*

Legend			
	Site boundary	Fort Southwick	Possible bomb cratering
	Southwick HAA battery	Paulsgrove Chalk Pit	

Plate 7 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site. Some possible bomb cratering can be seen to the south of the Site.

The Paulsgrove Chalk Pit has also been highlighted (see Section 3.6).

Plate 7 Aerial photograph (SU 642066), 19th April 1946



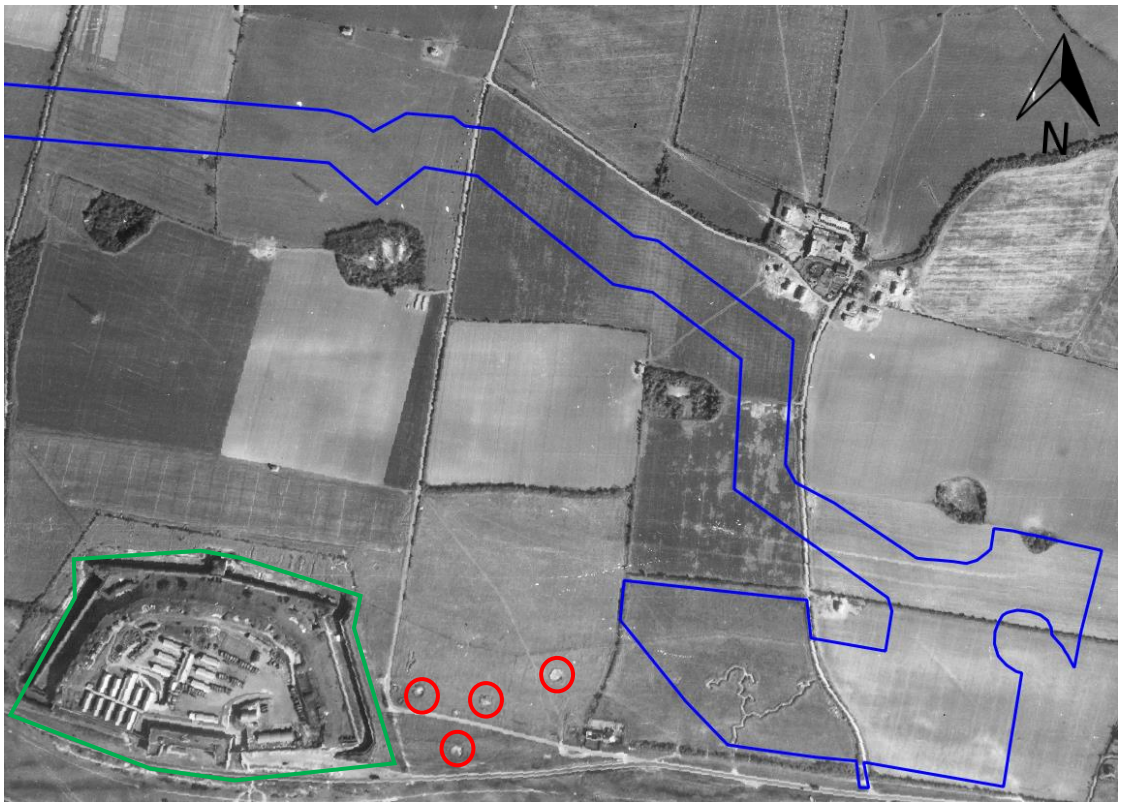
Source: Historic England *Not to Scale*

Legend	Site boundary	Paulsgrove Chalk Pit	Possible bomb cratering

Plate 8 is an aerial photograph dated the 19th April 1946. No bomb damage or cratering has been identified on the Site. Some possible bomb cratering can be seen to the south of the Site.

Fort Widley has been identified (see Section 3.1.1).

Plate 8 Aerial photograph (SU 663075), 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Fort Widley	Possible bomb cratering

Potential UXO hazard

Records have been found indicating that 2No. HE bombs and several IBs fell on the Site during WWII and exploded. IBs had a low HE content and were not designed to penetrate the ground (see Appendix 1).

No further records of bombing on the Site have been found and no bomb damage or cratering has been identified on the Site on historical aerial photography.

Bombing incidents in the area were the result of overspill from larger raids on central Portsmouth, over 4km south of the Site, with bombing densities dropping off in the immediate vicinity of the Site.

Given the active military presence on the Portsdown Hill, it is considered unlikely that any UXBs falling on the Site would have gone unnoticed.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of Made Ground and topsoil, overlying the Spetisbury Chalk Member and the Portsdown Chalk Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of topsoil (modelled as soft clay) overlying more than 20m of weak rock.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	5.5m
	250kg	8.5m
	500kg	14.0m

Where Made Ground was present, the estimated average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ^{o} to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

Between the 1860s and 1950s, the eastern part of the Site encroached on the Portsdown Military Lands. No significant sources of UXO hazard associated with the Portsdown Military Lands have been identified on the Site.

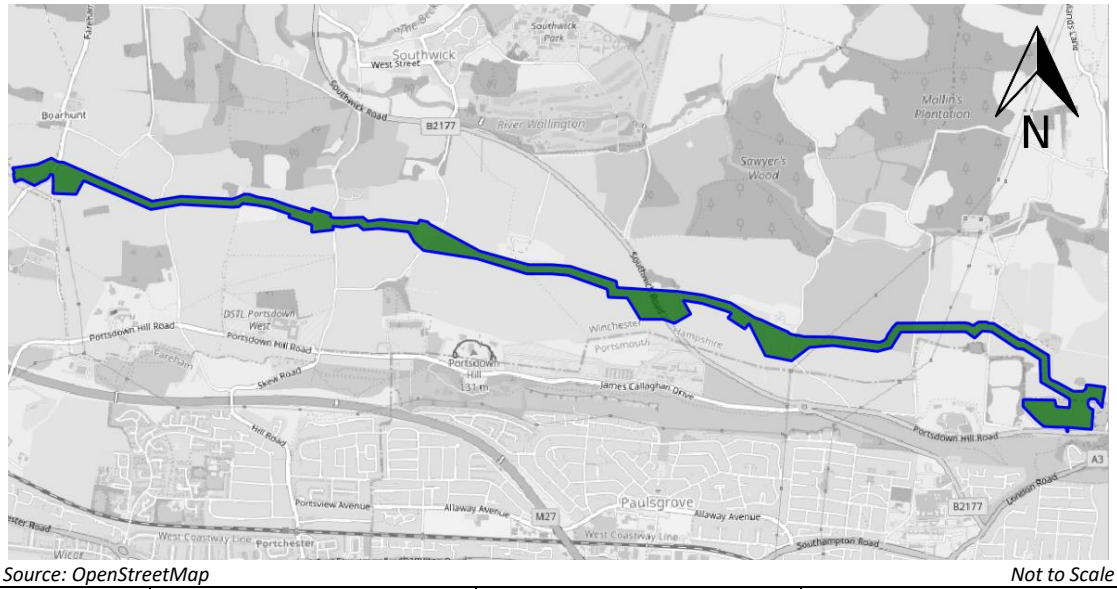
Additionally, records have been found indicating that 2No. HE bombs and several IBs fell on the Site and exploded during WWII.

No further bombing and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 5.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R10-MAP01-A.

Figure 5 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: UXO awareness briefing is recommended for all staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is recommended that all staff involved in excavation works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or have any comments, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

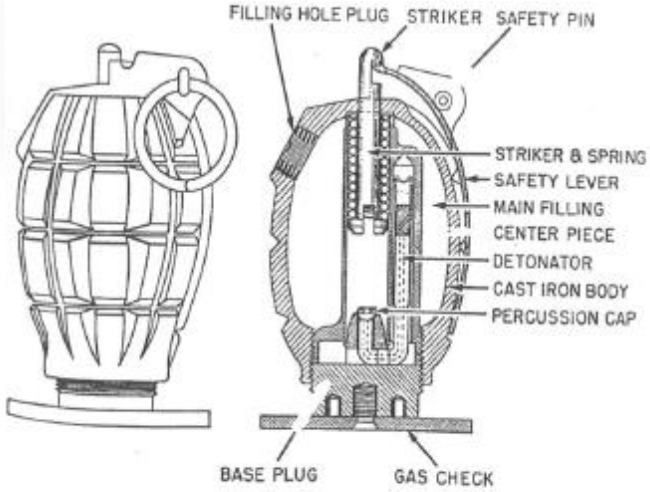
SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.





Information Data Sheet

Category Grenades (British)
Type No. 36 Hand Grenade ('Mills Bomb')



Variants	-	**Dimensions**	101.6mm x 61mm (4" x 2.4")
Weight	2 lbs	**Delay**	4 seconds
Filling	Baratol	**Material**	Cast Iron

Description Lemon-shaped, cast-iron body filled with high explosive. Three holes in the body; one in the base for priming, one near the top for filling; one on the top holding striker.

Function Used as a defence against enemy personnel.





Information Data Sheet

Category Grenades (British)
Type No. 76 Self-Igniting Phosphorus Grenade

Variants -

Dimensions 152.4mm x 63.5mm (6" x 2.5")

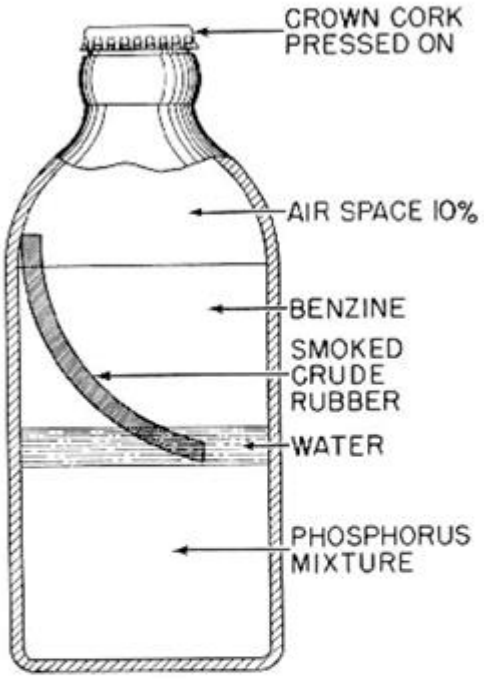
Weight 1lb

Fuze Self-igniting upon breakage

Material Glass

Description Glass bottle filled with white phosphorus, benzene, water and crude rubber.

Function Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.

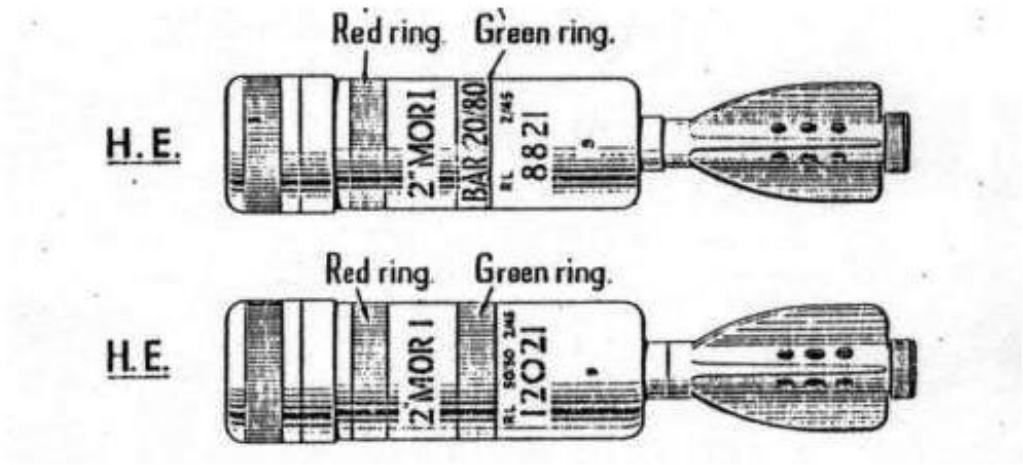






Information Data Sheet

Category Mortar (British)
Type 2-Inch Mortar Bomb



Variants	14	**Length**	11.4" x 2"
Weight	2.5lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	50.8mm (2.0 inches)	**Rate of Fire**	8 rounds per minute

Description Pear-shaped steel body with 6 or 8 vanes. Originally painted buff yellow or dark grey. Filled with c TNT, granular TNT or powdered Amatol. Also smoke, illumination and practice versions.

Function Small enough to be carried by one man, with a range limited to 500 yards, the 2" mortar was usec an anti-personnel role.

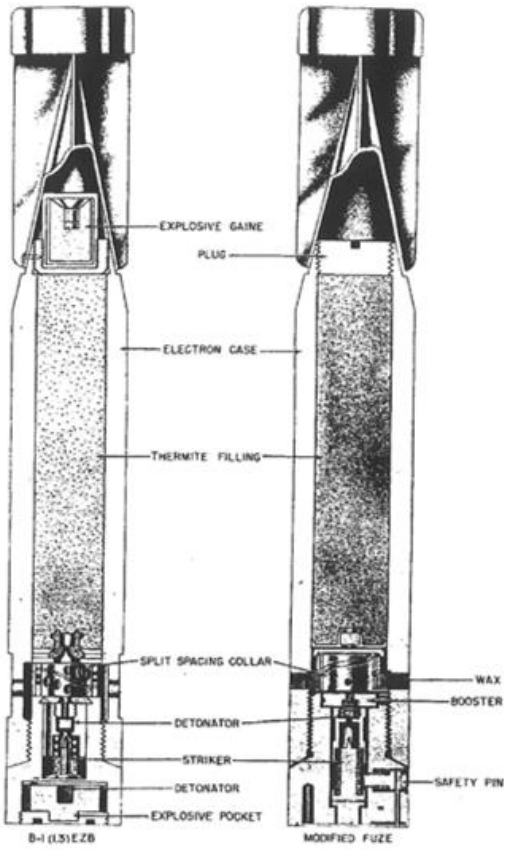




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 1kg

Variants	6
Body Dimensions	350mm x 50mm (13.8" x 1.97")
Weight	1kg & 1.3kg (2.2lbs & 2.86lbs)
Charge Weight	8 -15 gm (0.28 – 0.53 oz) in models with Nitropenta explosive. No charge in B-1 & B-1.3 E types.
Fuze	Impact fuze with safety plug
Composition	Sheet steel
Description	The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze. The after body is tapered to receive the sheet metal, three-fined drum-shrouded tail assembly. The bomb is unpainted magnesium; the tail is dark green.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations.



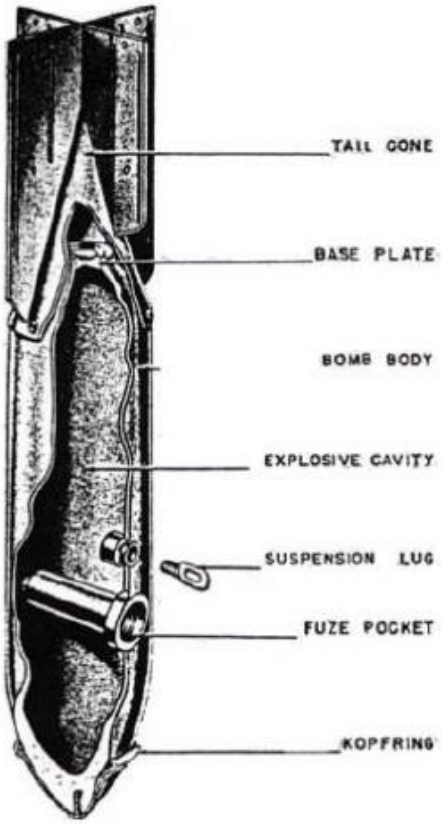




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



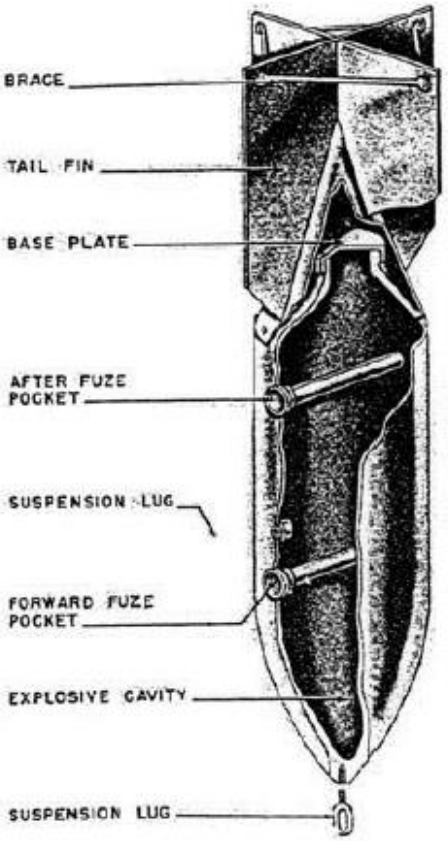




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



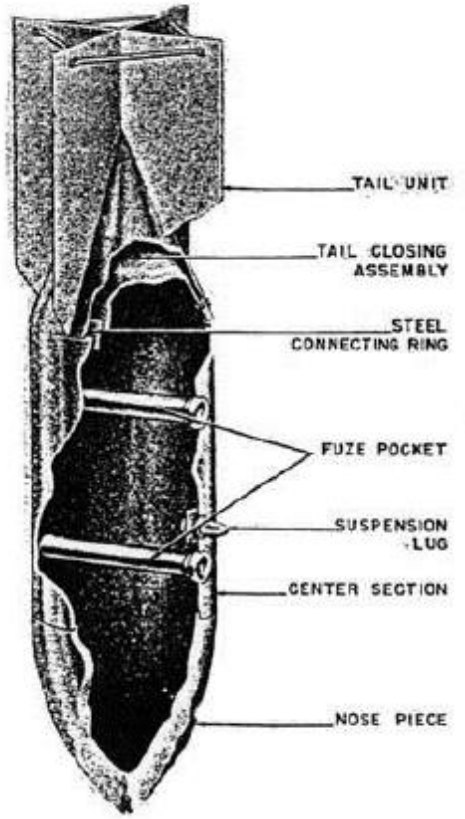




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

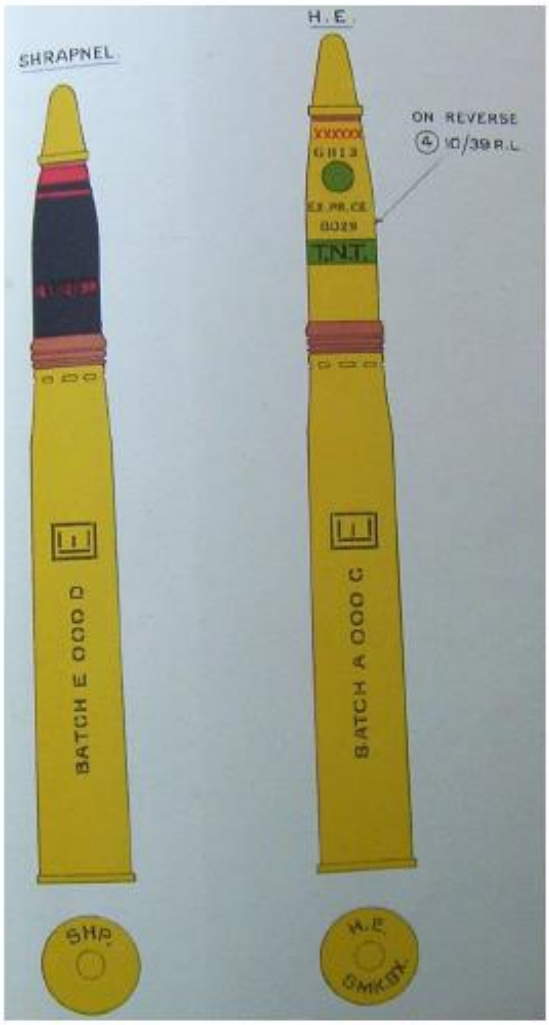
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

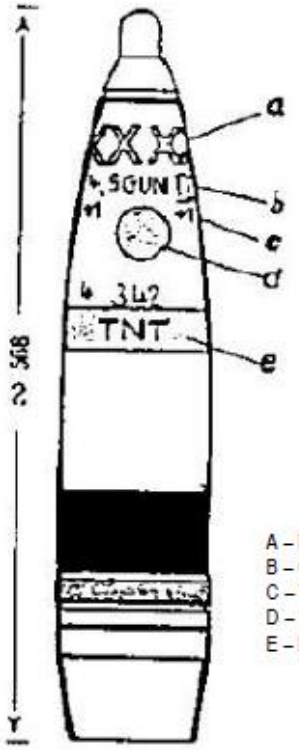
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

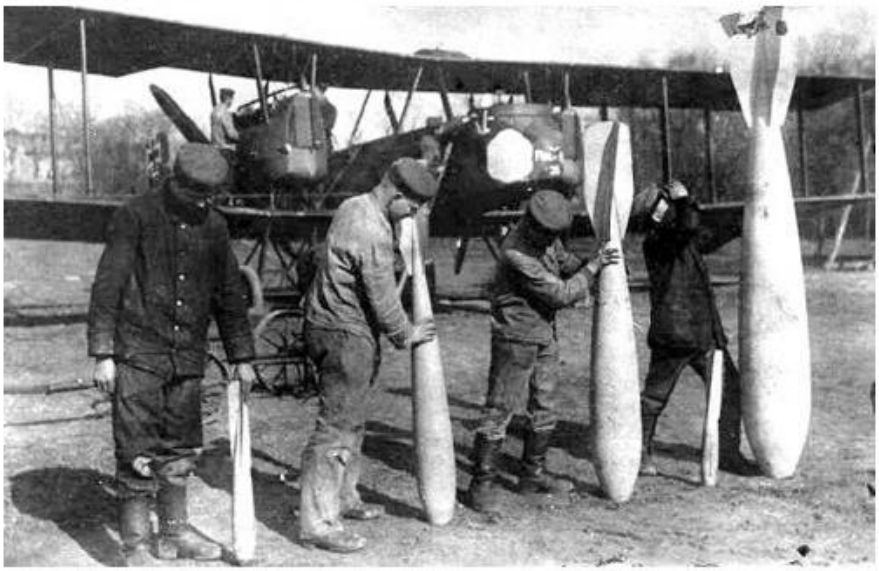
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 2.4 Aircraft Crashes

Information Data Sheet

Category Aircraft Crashes

Description:

Military aircraft operations will occasionally result in aircraft crashes, and they were especially common during the exigencies of wartime. Collisions, damage sustained during operational duty, pilot error, and adverse weather conditions were all causes for crashes.

The nature of aircraft crashes means that debris was often scattered over a wide area around the crash site, sometimes up to a distance of two miles.



Wreckage of a B-24 Flying Fortress bomber aircraft crash, WWII

Hazard:

Whether an aircraft crash provides a potential source of Unexploded Ordnance (UXO) hazard is largely dependent on the type of aircraft that crashed, its operational status, its ordnance load, and any efforts made to clear up the crash site.

Small Arms Ammunition (SAA) from the aircraft's defensive guns is the most common source of ordnance associated with aircraft crashes as it may scatter over a wide area. Some later aircraft designs were armed with 20mm cannons, the shells of which have High Explosive (HE) content. 20mm HE cannon shells would constitute a potential UXO hazard, whereas SAA is less significant.

Bomber aircraft crashing with full or partial bomb loads provide a further potential hazard. If the crash site was inaccessible or remote it would commonly not be investigated during wartime. As such, Unexploded Bombs (UXBs) from the aircraft may remain around bomber aircraft crash sites.

Post-World War Two (WWII) crash sites are typically more thoroughly cleared of debris and residues than those which occurred during wartime.

The Ministry of Defence (MoD) advises that if crashed aircraft are found, the safest policy is to leave them alone where possible. Unless disturbed there is no statutory requirement for the MoD to clear such sites. It should be noted that in some cases where a fatal crash site is located, the disturbance of the site may be prohibited due to its status as a war grave.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 [redacted] incident list

27th August 1940

Several IBs fell on Portsdown Hill, within approximately 0.2km southwest of the Site.

28th August 1940

1No. HE bomb fell on open ground south of the Southwick HAA Battery, approximately 80m south-southeast of the Site. This was recorded as an UXB.

1No. HE bomb fell on fields near Offwell Farm, approximately 0.3km north of the Site. This was recorded as an UXB.

16th November 1940

4No. HE bombs fell on open ground adjacent to Fort Widley, approximately 90m west-southwest of the Site.

22nd November 1940

1No. HE bomb fell on open ground near Fort Nelson, approximately 0.4km south of the Site.

27th November 1940

1No. HE bomb fell on open ground near Fort Southwick, approximately 0.2km south-southwest of the Site.

5th December 1940

Several IBs fell on Portsdown Hill, within approximately 0.3km south of the Site.

24th February 1941

1No. HE bomb fell on open ground at Widley Farm, approximately 0.1km north-northeast of the Site. This was recorded as an UXB.

10th March 1941

Several IBs fell on Widley and Purbrook, within approximately 0.3km east-northeast of the Site.

11th March 1941

Several IBs fell on open ground to the south of Pigeon House Farm, on the Site.

6No. HE bombs fell on open ground near Crooked Walk Lane, on and in close proximity to the Site.

2No. HE bombs fell on Pigeonhouse Lane, approximately 0.2km north of the Site.

12th March 1941

3No. HE bombs fell on open ground at Offwell Farm, approximately 20m south-southwest of the Site. These were all recorded as UXBs.

15th March 1941

Several IBs fell on open ground to the north of Fort Widley, within approximately 0.2km south of the Site.

16th April 1941

3No. HE bombs fell on Portsdown Hill near Fort Southwick, within approximately 0.1km south of the Site.

18th April 1941

HE bombs (number unspecified) fell on open ground to the rear of Fort Southwick, approximately 0.2km south-southwest of the Site.

2No. HE bombs fell on the military road on Portsdown Hill, approximately 0.4km south of the Site.

20th April 1941

1No. Parachute Mine (PM) fell on open ground east of the Southwick HAA battery, approximately 0.2km north of the Site. This was recorded as an Unexploded PM (UXPM).

1st June 1941

2No. HE bombs fell on Geoffrey Avenue, Widley, approximately 0.3km north-northeast of the Site.

26th June 1941

2No. PMs fell on Widley Farm, approximately 0.2km north-northeast of the Site. These were recorded as UXPMs.

8th July 1941

1No. HE bomb fell on open ground at New Barn Farm, approximately 20m north-northeast of the Site.

16th May 1944

2No. HE bombs fell on open ground near Offwell Farm, approximately 0.3km north-northeast of the Site. These were both recorded as an UXB.

23rd May 1944

2No. 50kg HE bombs fell on Offwell Farm, approximately 0.1km northeast of the Site. These were both recorded as UXBs.

Date Unknown

400No. IBs fell on open ground near the Old Chalk Pit, Offwell Farm, potentially including on the Site.

Appendix 6 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Easthope W G, Smitten City: The Story of Portsmouth under Blitz, 1981

Morris J, German Air Raids on Britain 1914-1918, 1993

Leete J, In Time of War: Hampshire, 2006

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 7 General Notes

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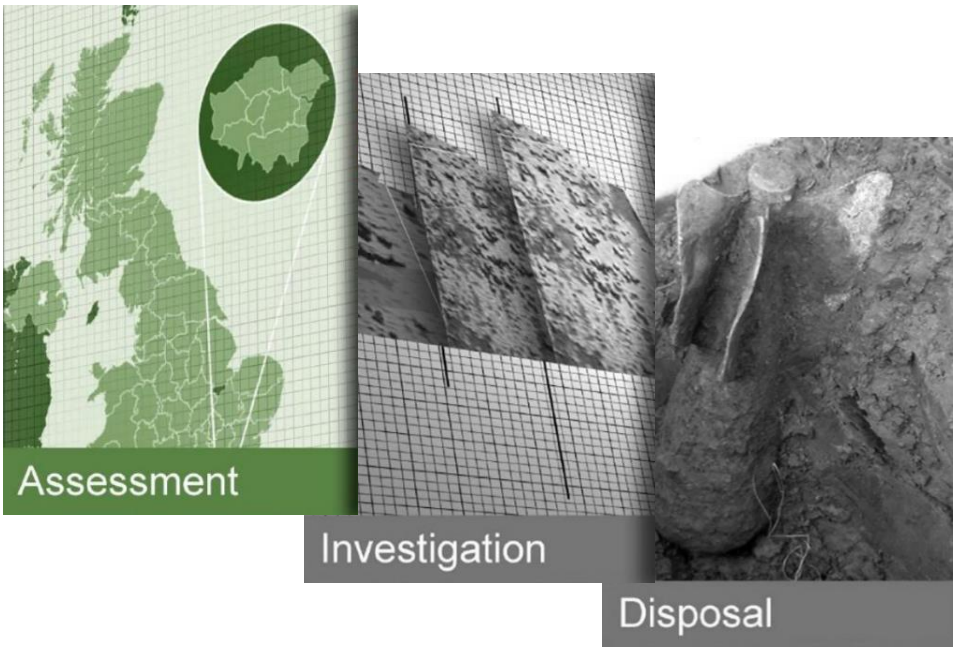
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R9**
Revision	**A**
Project Title	**F Site**
Client	**Southern Water**
Date	**26th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R9-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) have been found.
- During World War Two (WWII), the Site was located within Marshalling Area 'A'. It was used to build up concentrations of troops and supplies in preparation for D-Day, the allied invasion of Northern Europe.

- During WWII the main strategic targets in the vicinity of the Site included military camps, Fort Nelson, and Fareham train station.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 50m north of the Site.
- There were 16No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	**Low**
	HDD	1	1	1	1	4	4	**Low**
Other UXO	Excavations	1	1	1	1	4	4	**Low**
	HDD	1	1	1	1	3	3	**Low**
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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Accompanying GIS data

P14032-24-R9-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
CSD	Command Supply Depot
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
ESD	Embarkation Supply Depot
FAA	Fleet Air Arm
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HMS	His Majesty's Ship
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RAF	Royal Air Force
RE	Royal Engineers
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
TDS	Training Depot Station
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
UXPM	Unexploded Parachute Mine
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a pipeline route totalling approximately 3.4km between Crockerhill and Boarhunt in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, the Hampshire Records Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

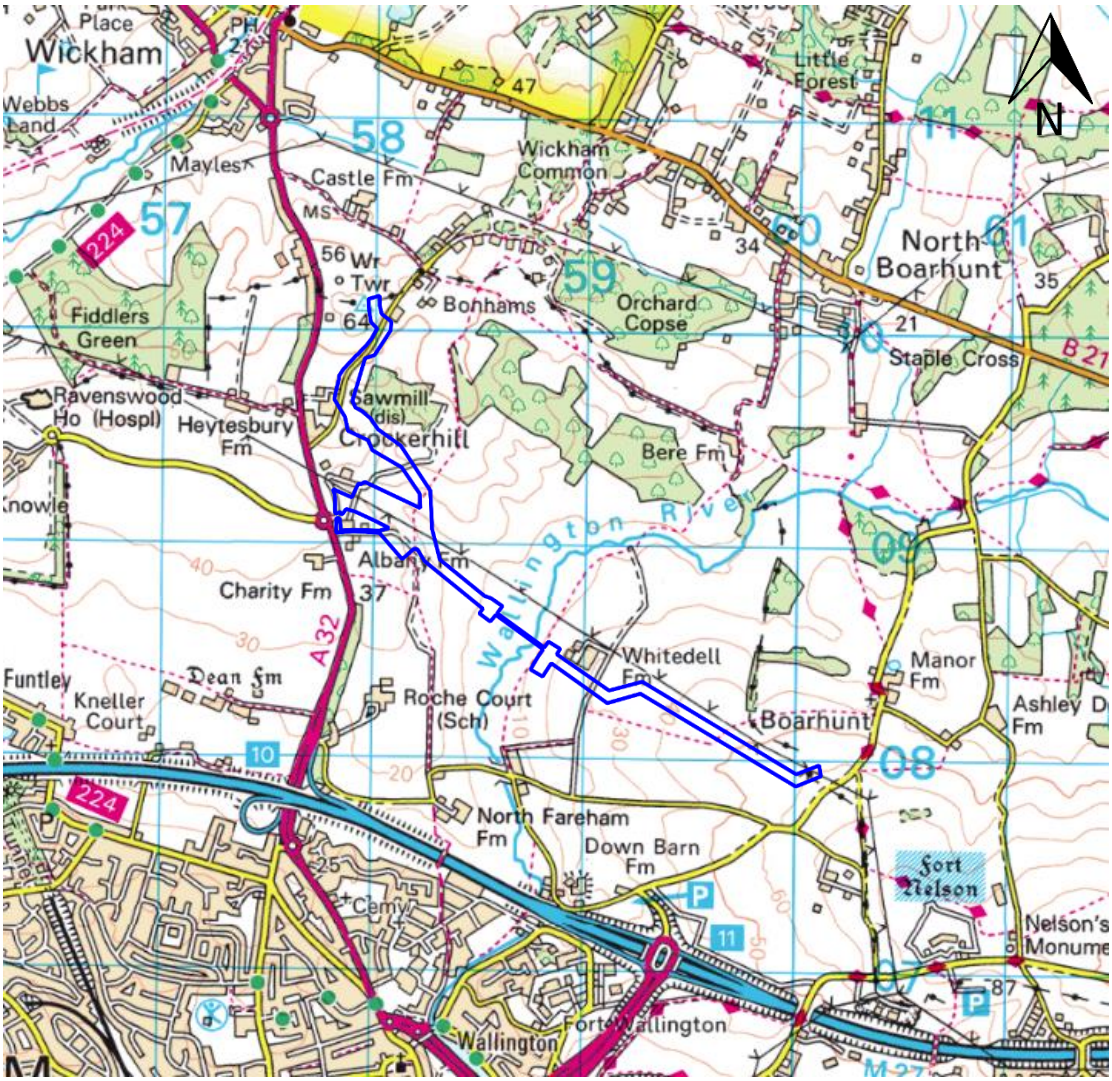
2.1 Site location

The Site commences at Crockerhill, at Ordnance Survey National Grid Reference (OSNGR) SU 579100 and terminates at Boarhunt OSNGR 600079. It is located approximately 2.5km northeast of central Fareham.

The Site comprises open ground and roadway. It is bounded to the north, east and south by open ground and woodland, and to the west by open ground, Wickham Road, and commercial buildings.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Marshalling Area 'A'

During WWII large concentrations of troops, equipment, and supplies were assembled in designated marshalling areas across southern England in preparation for the D-Day landings, the allied invasion of Northern Europe.

In early 1944 a wide area to the north of Portsmouth and east of Fareham, encompassing the Site, was designated as Marshalling Area 'A'. Several large accommodation camps, administrative facilities, stores, depots, and vehicle assembly areas were established within this area, including in the vicinity of the Site. The area was further divided into Sub-Areas 'W', 'X', 'Y', and 'Z'.

The Site was encroached on by Sub-Area 'Y' to the north and Sub-Area 'Z' to the south. These were localised assembly points for troops, vehicles, and supplies.

The nearest establishment was Camp A16, located at Roche Court within Sub-Area 'Z', approximately 0.5km south of the Site. This was an assembly camp with space for 2,000No. personnel and 444No. vehicles. It was the headquarters for Marshalling Area 'A'. From 30th December 1943 to 30th May 1944, Canadian troops from the Stormont, Dundas & Glengarry Highlanders were stationed at the camp.

Figure 2 is an extract plan of Marshalling Area 'A', dating from 1944. This shows several features, including Camp A16 (marked with a black flag), vehicle recovery posts (RP3 and RP9), an Embarkation Supply Depot (ESD) and a Command Supply Depot (CSD).

Figure 2 Plan of Marshalling Area 'A', 1944



Source: Google Earth *Not to Scale*

Legend	Site boundary	Sub-Area boundary
	One-way route	Two-way route

Ad hoc military training is known to have occurred in D-Day marshalling areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on the Site on historical aerial photography (see Plate 3).

After WWII, Marshalling Area 'A' was disbanded.

Marshalling Area A is not considered to provide a source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.2.1 Anti-Aircraft (AA) guns

During WWI there were 16No. AA batteries recorded within 10km of the Site. The nearest was located at Fort Southwick (SU 628069), approximately 2.9km southeast of the Site. It was armed with 1No. 18-pounder (pdr) gun.

During WWII there were 16No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Fort Nelson (SU 601076), approximately 0.4km south of the Site. It was armed with 4No. 5.25" guns and was manned by units from the 391st AA Company, part of the 35th AA Brigade.

Plate 2 is an aerial photograph dated the 13th February 1943. The Fort Nelson HAA battery has been identified.

Plate 2 Aerial photograph, 13th February 1943



Source: Historic England *Not to Scale*

Legend	Site boundary	HAA battery

The nearest recorded WWII AA shell incident to the Site is described below.

19th July 1944

1No. AA shell fell on open ground near Wickham, approximately 0.9km north of the Site. This was recorded as an Unexploded AA (UXAA) shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI and WWII, the nearest operational airfield was Royal Naval Air Station (RNAS) Lee-on-Solent/His Majesty's Ship (HMS) Daedalus, approximately 6.3km southwest of the Site.

RNAS Lee-on-Solent was established in July 1917 as the Naval Seaplane Training School, operating Short Type 827 floatplanes. In 1918, when the RNAS and Royal Flying Corps (RFC) were

merged, it became the Royal Air Force (RAF) Lee-on-Solent and continued to provide naval aviation training.

After WWI, RAF Lee-on-Solent continued to operate as a Training Depot Station (TDS), becoming the School of Naval Co-Operation in May 1923.

In May 1939 RAF Lee-on-Solent was transferred to the Fleet Air Arm (FAA) and commissioned as HMS Daedalus. Units based there included No. 780 Naval Air Squadron, a training unit operating de Havilland DH.6-0 Moth trainer aircraft and Hawker Hart bomber aircraft.

After WWII, HMS Daedalus continued in use. On the 31st October 1959, it was renamed HMS Aerial to reflect its focus on electrical, radar, and ground training. In 1965, it reverted to the name HMS Daedalus.

In 1988, naval flying ceased at HMS Daedalus. The airfield continued in use for civilian flying by the Hampshire Police Air Support Unit until 1996.

The airfield is currently known as Solent Airport, a civilian airfield, and is home to the Maritime & Coastguard Agency.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.5 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.6 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Fareham and Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over a third of the total number of bombs falling in Hampshire fell on Southampton, approximately 18.4km northwest of the Site, and Portsmouth, approximately 5km southeast of the Site.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial areas in Hampshire. Operational airfields in Hampshire, including RNAS Lee-on-Solent/HMS Daedalus, were deliberately targeted by the Luftwaffe.

The distinctive coastline of the region was a major navigational aid for German bombers on their route to the strategic target areas around Portsmouth and further inland. The was also subjected to 'tip and run' bombing raids.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in a predominantly rural area which contained few strategic targets. The main strategic target in the vicinity of the Site was Fort Nelson, approximately 0.9km southeast of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Flying Bombs (V1s), Long-Range Rockets (V2s), and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Fareham UD	**447**	**11**	**18**	**476**	**25.9**
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Gosport MB	587	4	10	601	97.3
Havant & Waterloo UD	375	39	9	423	35.0

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

16th August 1940

1No. Parachute Mine (PM) fell on open ground south of Bere Farm, approximately 0.8km north-northeast of the Site. This was recorded as an Unexploded PM (UXPM).

30th October 1940

2No. High Explosive (HE) bombs fell on Wickham Common, approximately 0.8km north-northeast of the Site.

9th – 10th January 1941

2No. HEs and 2No. IBs fell on open ground near Fort Nelson, approximately 0.8km southeast of the Site.

Date Unspecified

2No. HE bombs fell on open ground near Hoad's Hill, within approximately 80m north of the Site.

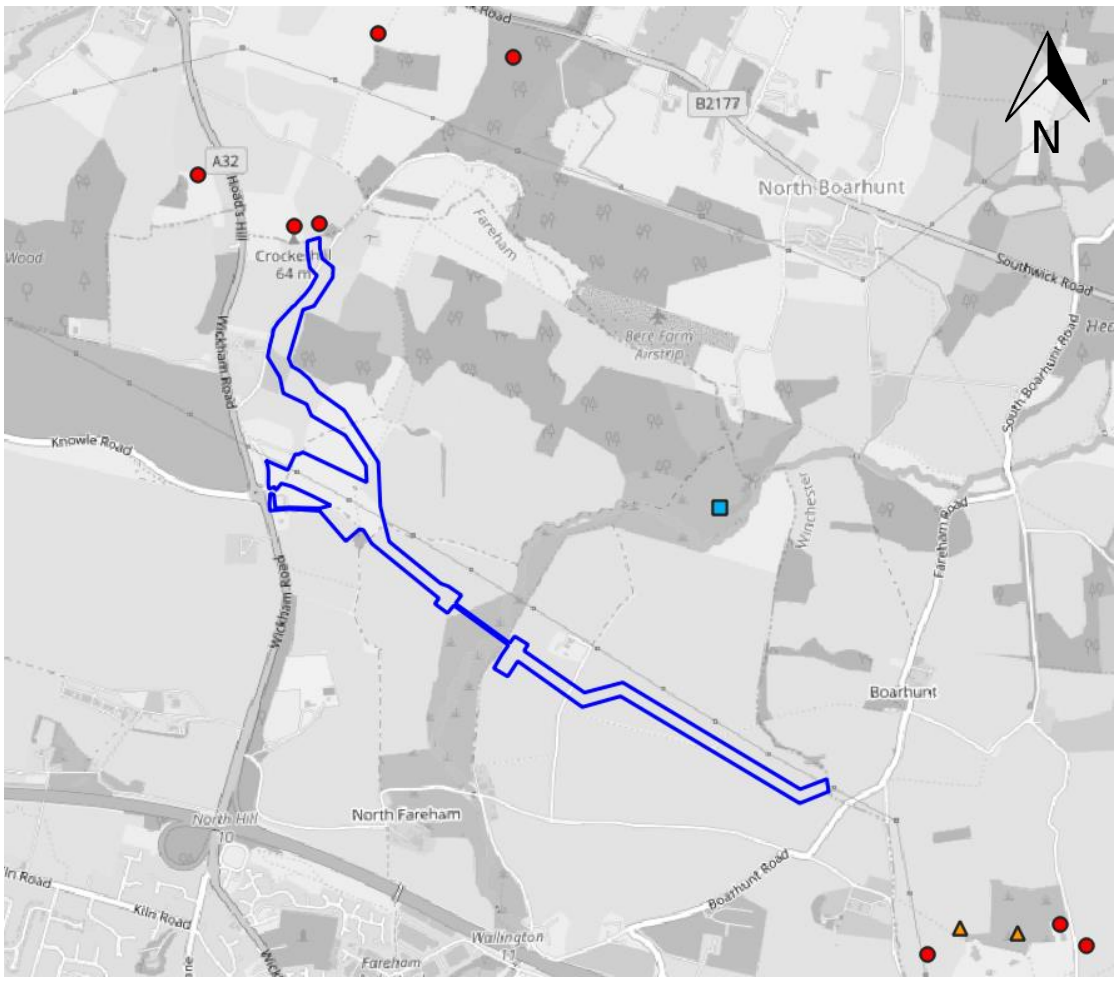
1No. HE bomb fell on open ground near Martin's Copse, approximately 0.5km northwest of the Site.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R9-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the Site

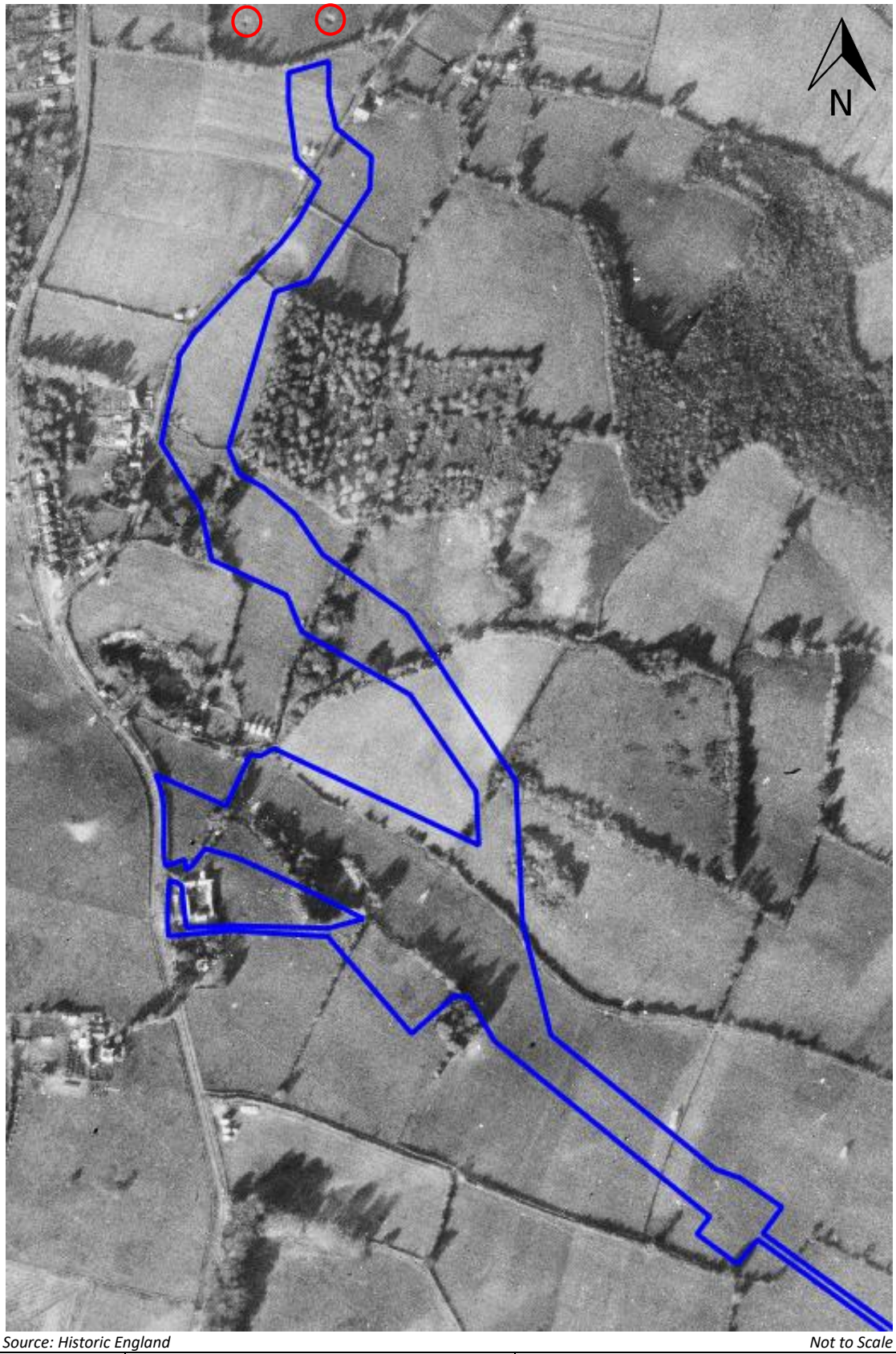


Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXPM	IBs

Plate 3 is an aerial photograph of the northern part of the Site dated the 4th November 1946. 2No. possible bomb craters have been identified to the north of the Site.

Plate 3 Aerial photograph, 4th November 1946

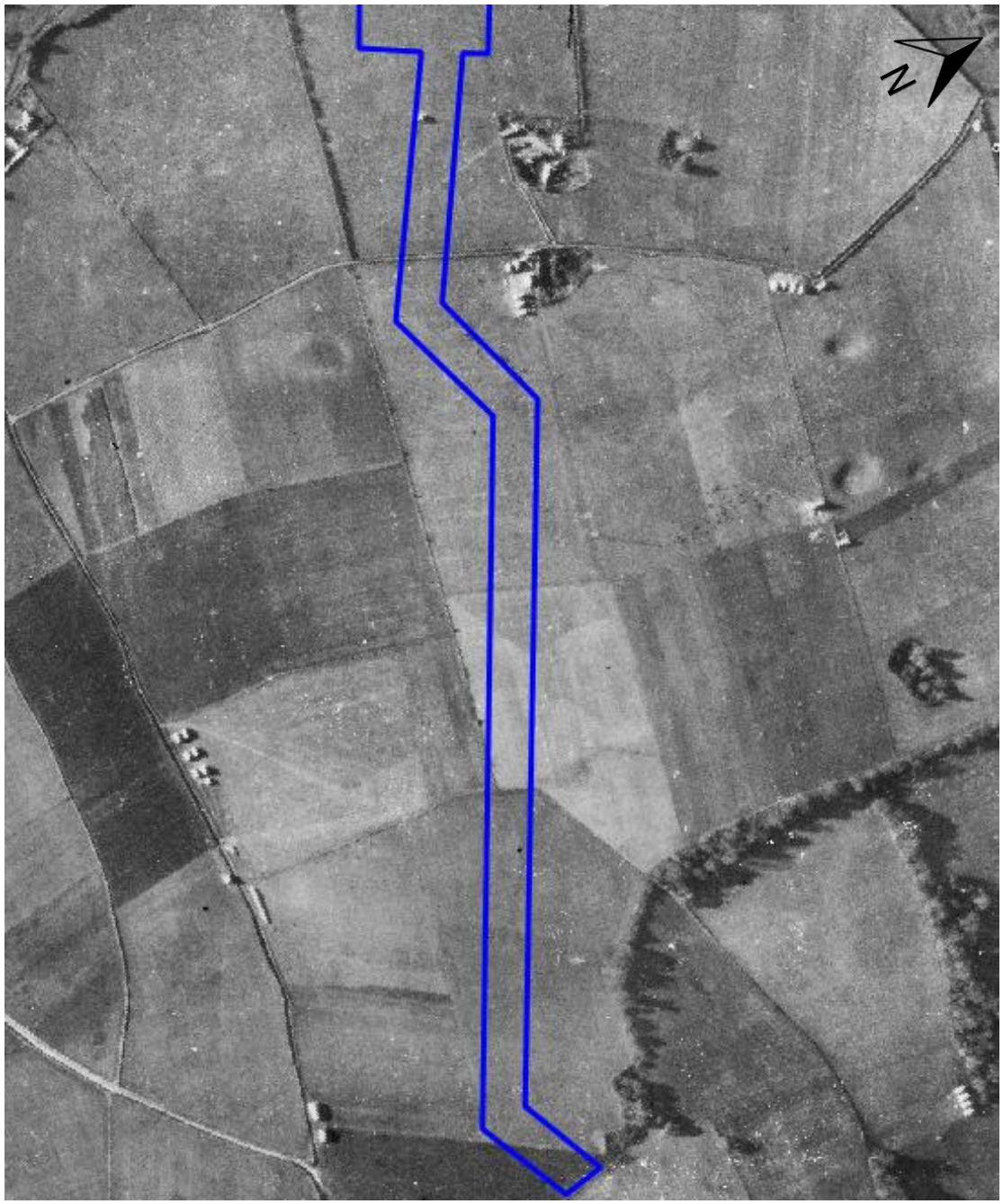


Source: Historic England *Not to Scale*

Legend	Site boundary	Possible cratering

Plate 4 is an aerial photograph of the southern part of the Site, dated 4th November 1946. No bomb damage or cratering has been identified on this part of the Site.

Plate 4 Aerial photograph, 4th November 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground, over silt, gravel, and sand, overlying chalk.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of topsoil, over 1m of silt and sand, 1m of clay, and 2.5m of gravel, overlying more than 20m of chalk.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.5m
	250kg	4.5m
	500kg	9.5m

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place on or in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

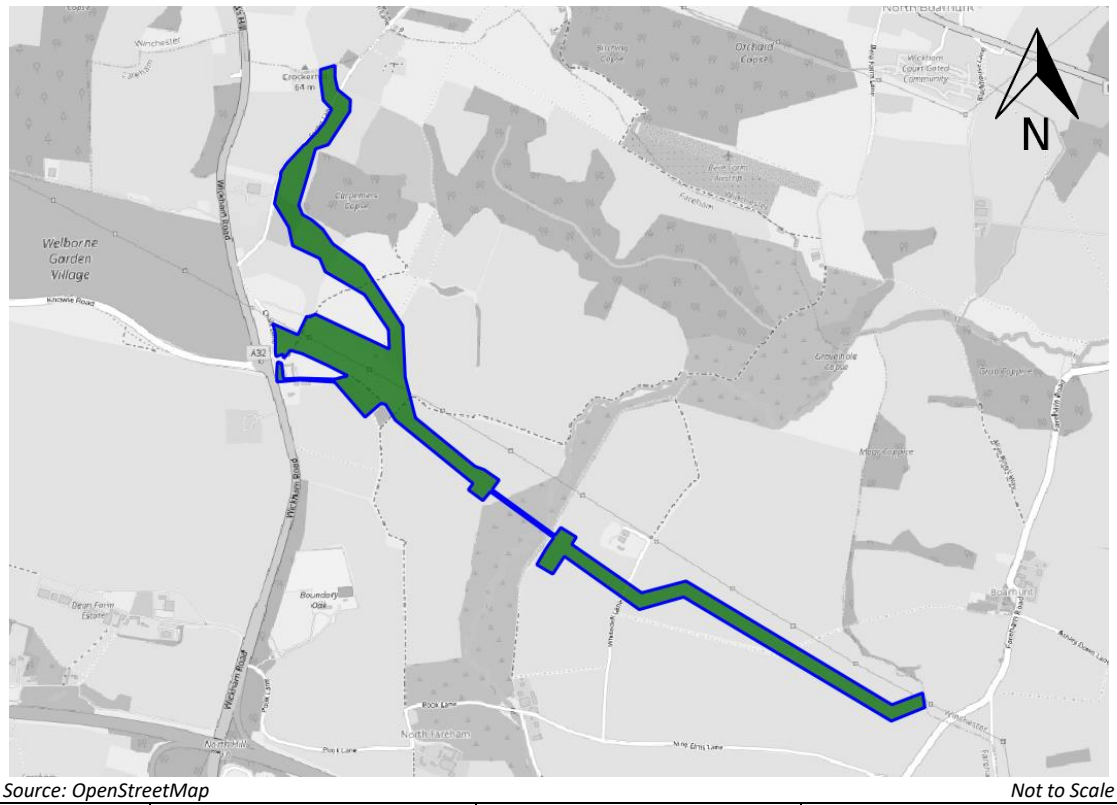
Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R9-MAP01-A.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

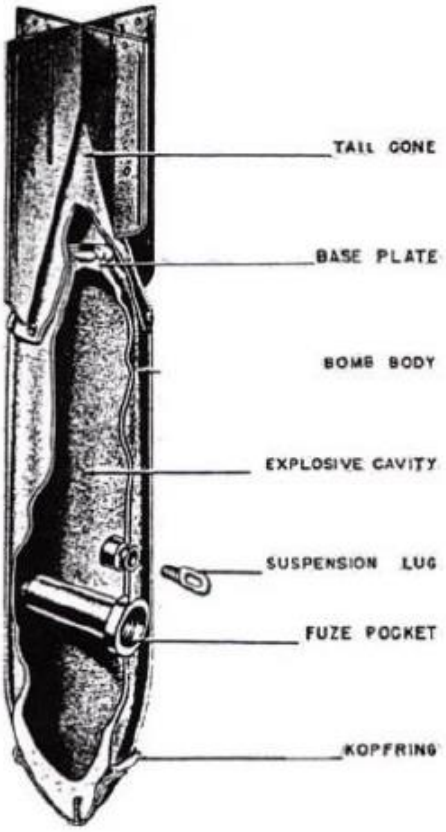
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



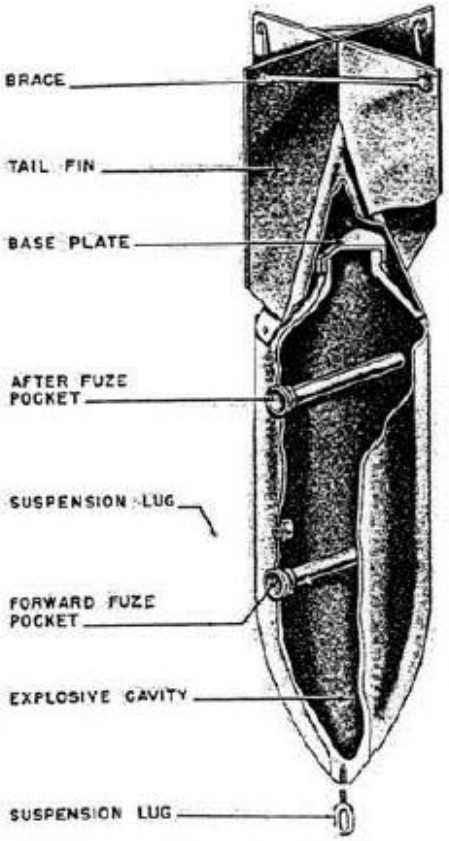




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



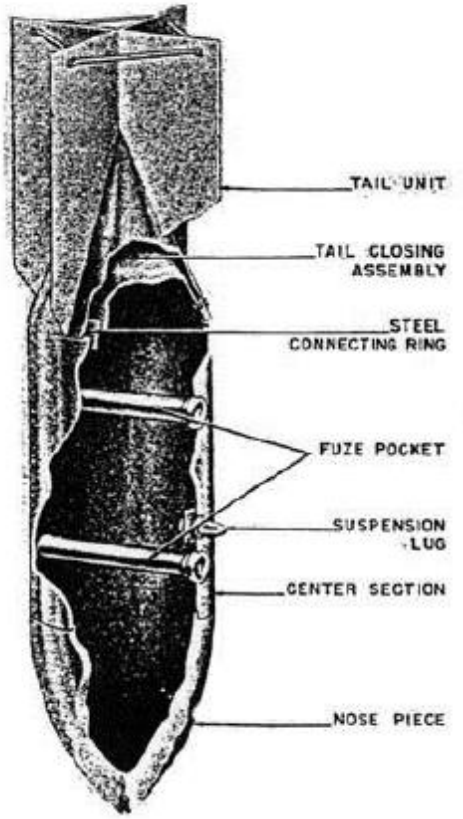




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



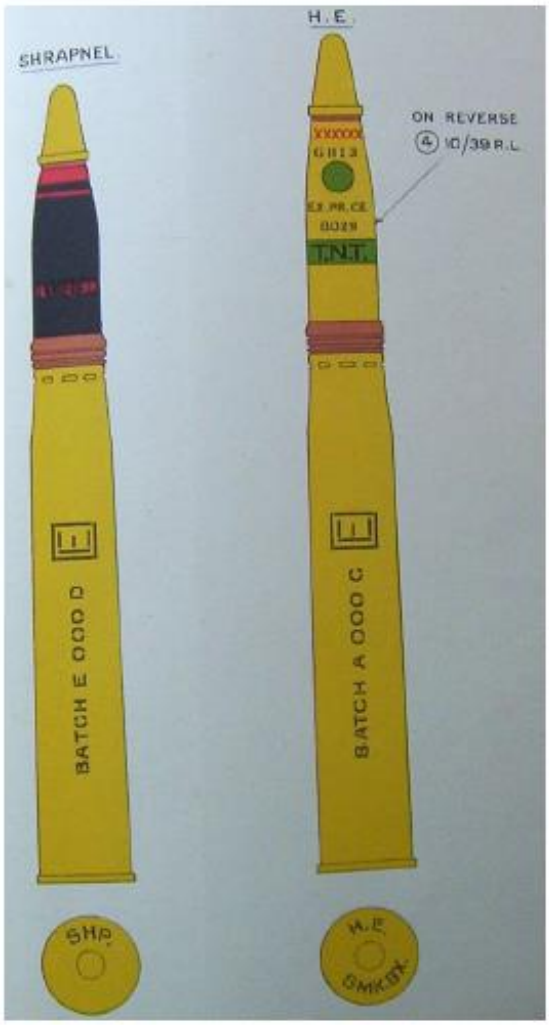




Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

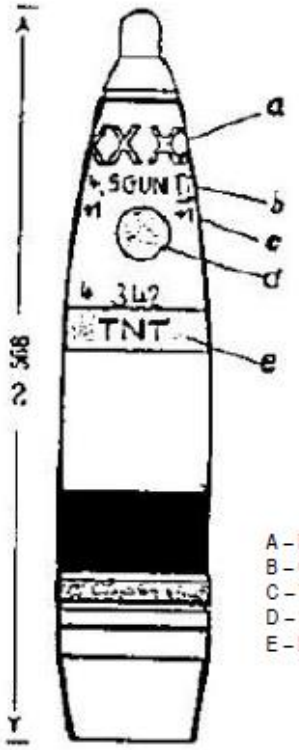
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

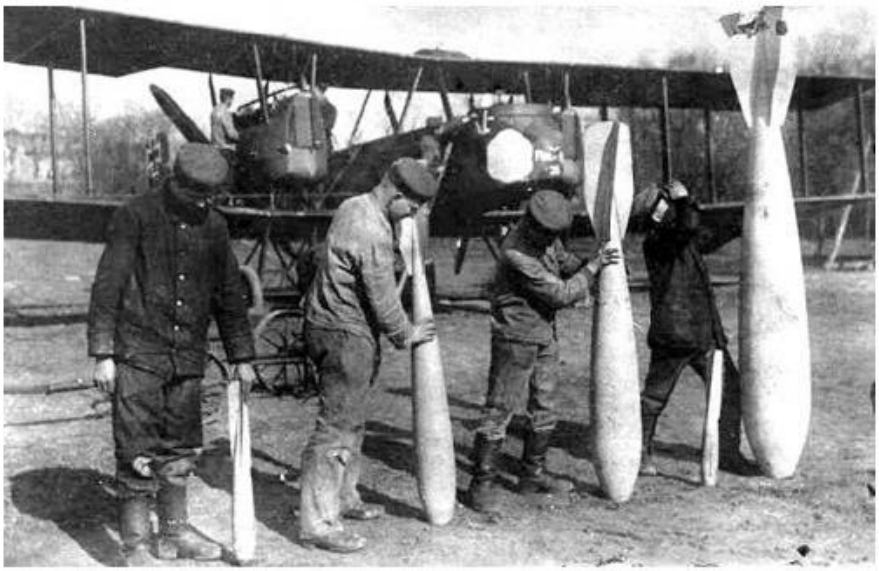
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Lee D W, Action Stations Revisited 3, 2010

Leete J, In Time of War – Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War 1939 – 45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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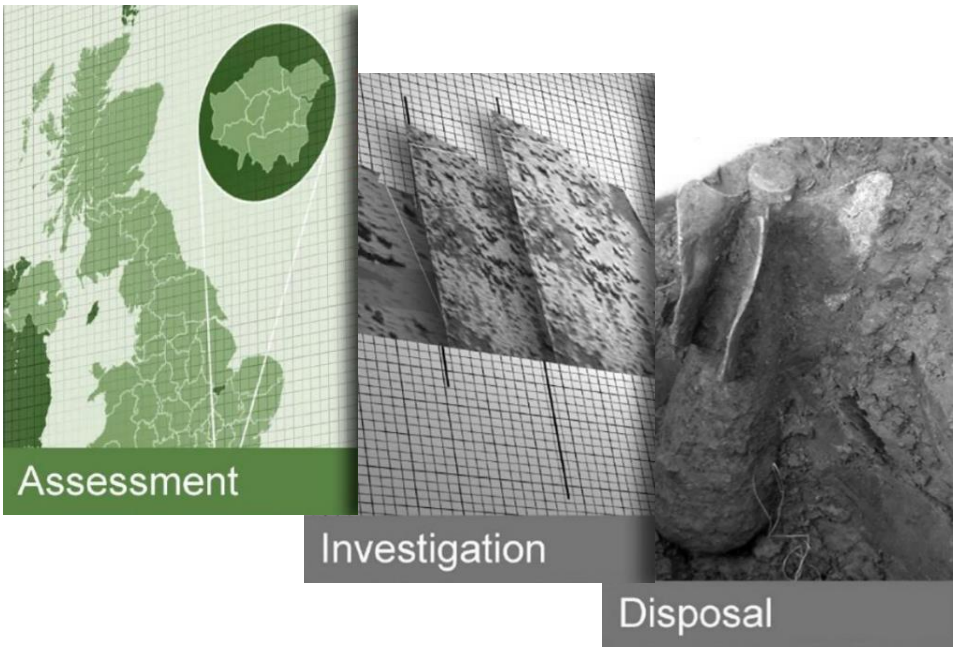
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R1**
Revision	**A**
Project Title	**G Site**
Client	**Southern Water**
Date	**5th April 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: UXO awareness briefing is recommended for all staff involved in excavations.

UXO hazard assessment

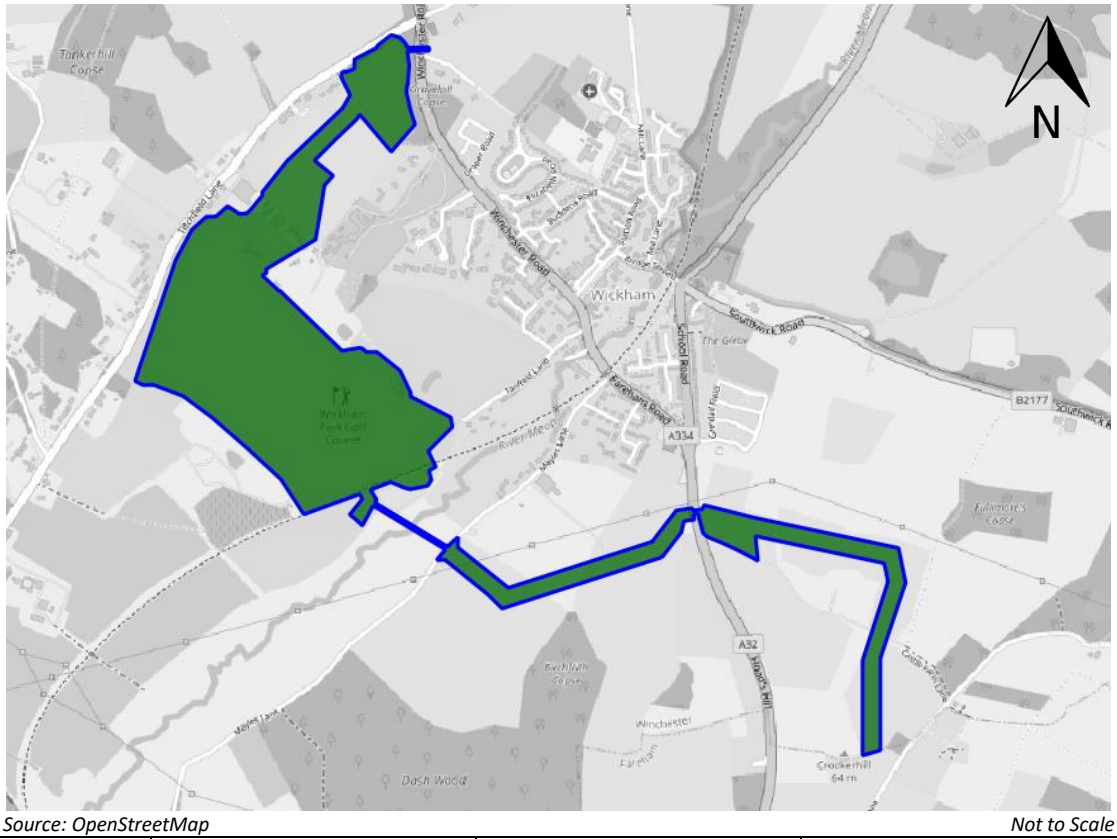
Records have been found indicating that 4No. High Explosive (HE) bombs and several Incendiary Bombs (IBs) fell on the Site and exploded during World War Two (WWII).

No further bombing and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R8-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) have been found.

- During World War Two (WWII), the Site was encompassed by Marshalling Area 'A'. It was used to build up concentrations of troops and supplies in preparation for D-Day, the allied invasion of Northern Europe.
- During WWII the main strategic targets in the vicinity of the Site included military camps, depots, and transport infrastructure.
- Records have been found indicating that 4No. HE bombs and several IBs fell on the Site during WWII and exploded.
- There were 12No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

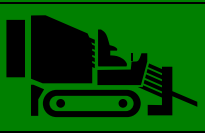
UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – given the history of military activity in the vicinity of the Site, it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

What do I do next?

If you require a quote for an awareness briefing or have questions, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

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Accompanying GIS data

P14032-24-R8-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
ELG	Emergency Landing Ground
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RAF	Royal Air Force
RE	Royal Engineers
RFC	Royal Flying Corps
RLG	Relief Landing Ground
RNAS	Royal Naval Air Station
SAA	Small Arms Ammunition
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WVS	Women's Voluntary Services
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a pipeline route totalling approximately 3.9km between Wickham and Crockerhill in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, the Hampshire Records Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

2.1 Site location

The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU 566108. It is located approximately 4km north of central Fareham.

The Site comprises open ground, woodland, part of Wickham Park Golf Course, and roadway. It is bounded to the north by open ground, woodland, and commercial buildings, and to the east and west by open ground, woodland, and residential buildings, and to the south by open ground, woodland, and roadway.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

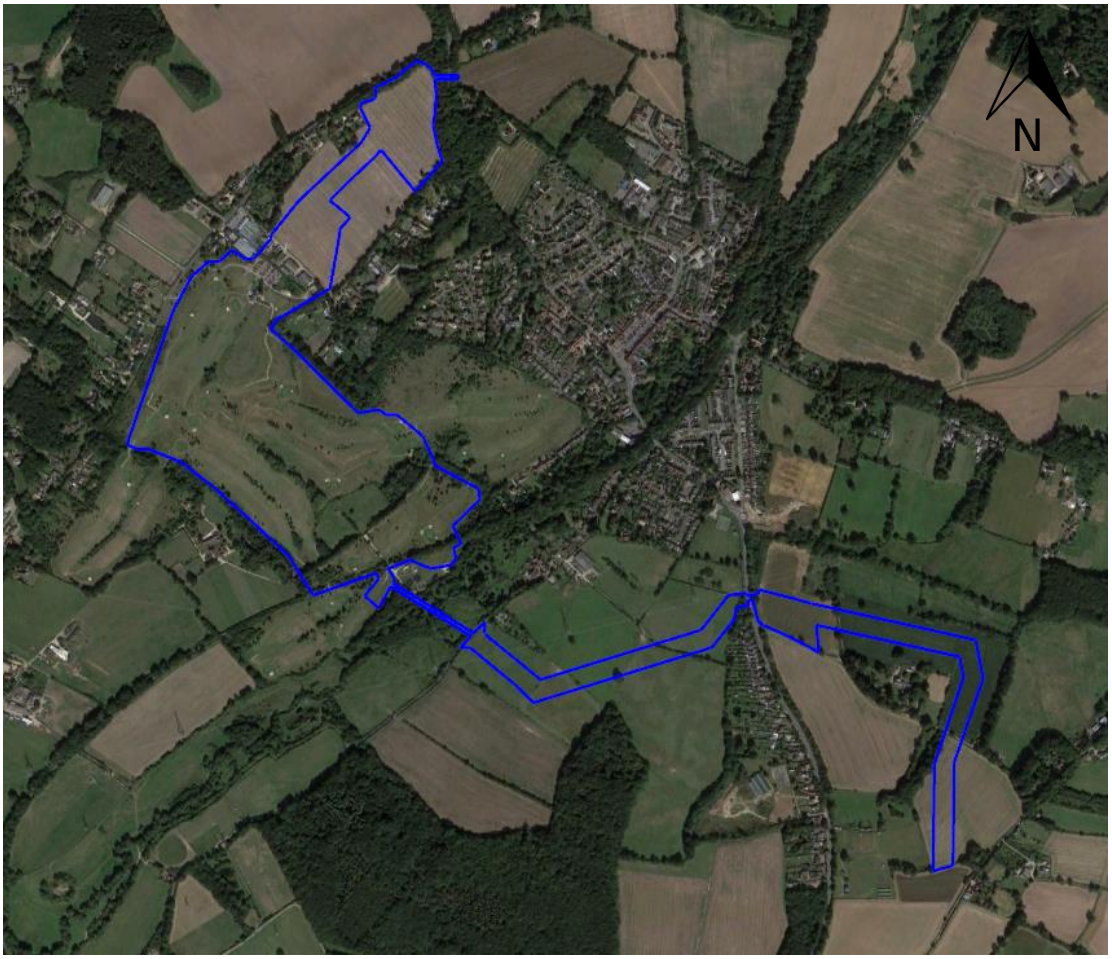
Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Marshalling Area 'A'

During WWII large concentrations of troops, equipment, and supplies were assembled in designated marshalling areas across southern England in preparation for the D-Day landings, the allied invasion of Northern Europe.

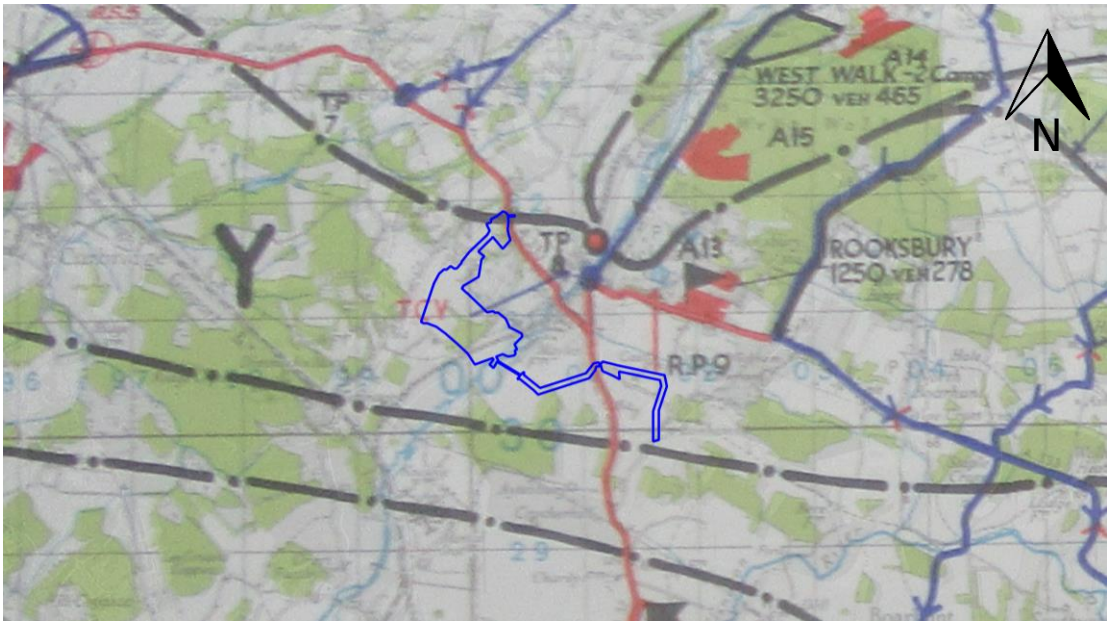
In early 1944 a wide area to the north of Portsmouth and east of Fareham, encompassing the Site, was designated as Marshalling Area 'A'. Several large accommodation camps, administrative facilities, stores, depots, and vehicle assembly areas were established within this area, including at Wickham, in the vicinity of the Site.

The Site was encompassed by Sub-Area 'Y', a localised assembly point for allied troops, vehicles, and supplies.

The nearest establishment was Troop Camp A13 in Sub-Area 'Y', located at Rookesbury Park, approximately 0.5km north of the Site. This was an auxiliary camp comprising several Nissen huts, and accommodated up to 1,250No. personnel and 278No. vehicles. Canadian troops from the Stormont, Dundas & Glengarry Highlanders camped at Rookesbury Park.

Figure 2 is an extract from a plan of Marshalling Area 'A', dating from 1944. This shows that Hoad's Hill, crossing the Site, was used for troop and vehicle movement. Records indicate that ammunition supply vehicles were parked on hardstanding along Hoad's Hill.

Figure 2 Plan of Marshalling Area 'A', 1944



Source: The National Archives *Not to Scale*

Legend	Site boundary	Sub-Area boundary	Sub-Area headquarters
	Marshalling camp	Traffic route	
	Traffic post	Detention point	

In late April 1944 the troops rehearsed moving from marshalling areas to embarkation areas, as part of Exercise 'Fabius'.

From the 31st May 1944 troops began to move in several waves from their marshalling areas down towards Portsmouth for embarkation.

On 16th July 1944, an ammunition lorry parked on hardstanding off Hoad's Hill, on the eastern part of the Site (SU 576107), caught fire and exploded, scattering ammunition and debris over the surrounding area.

From September 1944 marshalling areas and camps in southern England were no longer required and were dismantled.

Potential UXO hazard

It is considered likely that most ammunition and debris from the lorry explosion on the Site would have been searched for and removed during subsequent clean-up efforts. The possibility that some scattered ammunition remains on the Site cannot be totally discounted.

Ad hoc military training is known to have occurred in D-Day marshalling areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on the Site on historical aerial photography (see Plates 2 and 3).

Marshalling Area 'A' is not considered to provide a significant source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.2.1 Anti-Aircraft (AA) guns

During WWI there were 12No. AA batteries recorded within 10km of the Site. The nearest was located at Titchfield (SU 544057), approximately 5.6km southwest of the Site. It was armed with 1No. 18-pounder (pdr) gun.

During WWII there were 12No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Fort Nelson (SU 601076), approximately 3.3km southeast of the Site. It was armed with 4No. 5.25" guns.

The nearest recorded WWII AA shell incidents to the Site are described below.

4th September 1940

1No. AA shell fell on the garden of a house on Mill Lane, Wickham, approximately 0.7km east of

the Site. This was recorded as an Unexploded AA (UXAA) shell.

1st December 1940

3No. AA shell fell on Budden's Farm, Wickham, approximately 0.7km east-southeast of the Site. 1No. was recorded as an UXAA shell.

4th – 5th May 1942

1No. AA shell fell on woodland off Winchester Road, Wickham, approximately 0.2km southeast of the Site. This was recorded as an UXAA shell.

20th August 1942

1No. AA shell fell on Budden's Farm, Wickham, approximately 0.5km east-southeast of the Site. This was recorded as an UXAA shell.

28th March 1944

1No. AA shell fell on the playground of Wickham Junior School, approximately 0.7km north of the Site. This was recorded as an UXAA shell.

27th April 1944

1No. AA shell fell on open ground near Wickham, approximately 0.7km northeast of the Site. This was recorded as an UXAA shell.

7th June 1944

1No. AA shell fell on a field at Park Place, adjacent to the Site. This was recorded as an UXAA shell.

19th July 1944

1No. AA shell fell on open ground south of Rookesbury Park, approximately 0.3km north-northeast of the Site. This was recorded as an UXAA shell.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed cannot be totally discounted.

3.2.2 Bombing decoys

The nearest recorded bombing decoy was located at Botley (SU 515116), approximately 4.4km west of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Naval Air Station (RNAS) Lee-on-Solent, approximately 7.1km south of the Site. The airfield opened in 1917 and was used primarily for training with seaplanes.

After WWI, it remained in use for training purposes. It is currently a civilian airfield known as Solent Airport Daedalus.

During WWII, the nearest operational airfield was RAF Soberton, approximately 6.1km northeast of the Site. The airfield opened in 1940. It was designated as a Reserve Landing Ground (RLG) for other airfields in the region, in the event that they should become unusable. It was also used as an Emergency Landing Ground (ELG) for aircraft in distress.

After WWII, RAF Soberton closed and returned to agricultural use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found. The nearest is detailed below.

1st November 1940

1No. Hawker Hurricane Mk I (N2608, AK-F) fighter aircraft crashed on a field between Frith Farm and Prickett's Hill (SU 571128), approximately 0.8km north-northeast of the Site.

WWII

1No. Supermarine Spitfire fighter aircraft crashed on Station Field, Wickham, approximately 0.7km east of the Site. The aircraft was subsequently recovered by a salvage team.

Potential UXO hazard

The above aircraft crashes may have resulted in the scatter of Small Arms Ammunition (SAA) from the aircraft guns over a wide area, potentially including the Site.

SAA is not considered to provide a significant UXO hazard (see Appendix 1).

Aircraft crashes are not considered to provide a significant source of UXO hazard to the Site.

3.5 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.6 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

3.7 Other military establishments

3.7.1 Park Place

Park Place, approximately 20m east of the Site, was requisitioned in September 1940 as part of the dispersal of production activities of the Supermarine works at Woolston, approximately 12.3km west of the Site.

Members of the Women's Voluntary Services (WVS) worked at Park Place and were responsible for sorting rivets.

Park Place is not considered to provide a source of UXO hazard to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

Records have been found indicating that parts of the Site were bombed during WWII. Details of [redacted] on and in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Fareham and Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over a third of the total number of bombs falling in Hampshire fell on Southampton, approximately 18.4km northwest of the Site, and Portsmouth, approximately 5km southeast of the Site.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial areas in Hampshire. Operational airfields in Hampshire, including RNAS Lee-on-Solent/HMS Daedalus, were deliberately targeted by the Luftwaffe.

The distinctive coastline of the region was a major navigational aid for German bombers on their route to the strategic target areas around Portsmouth and further inland. The was also subjected to 'tip and run' bombing raids.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in a predominantly rural area which contained few strategic targets. The main strategic targets in the vicinity of the Site comprised military camps and depots, such as Fort Nelson, approximately 0.9km southeast of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Flying Bombs (V1s), Long-Range Rockets (V2s), and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Gosport MB	587	4	10	601	97.3
Havant & Waterloo UD	375	39	9	423	35.0
Fareham UD	447	11	18	476	25.9

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

24th September 1940

1No. High Explosive (HE) bomb fell on Wickham Common, approximately 0.5km east of the Site.

30th October 1940

2No. HE bombs fell on open ground between Hoad's Hill and Forest Lane, on and approximately 60m west of the Site.

2No. HE bombs fell on Wickham Common, approximately 70m east and 0.4km north-northeast of the Site.

9No. HE bombs fell on land at Fiddlers Green, east of Mayles Lane, between approximately 0.2km and 0.5km south-southwest of the Site.

Several HE bombs fell in the vicinity of Wickham, between approximately 0.4km and 0.5km east

of the Site. 2No. were recorded as UXBs.

25th November 1940

Several HE bombs fell on land northwest of Titchfield Lane, between Redhill Copse and Tankerhill Copse, between approximately 0.1km and 0.5km northwest of the Site.

1No. HE bomb fell on land at Quob Farm, approximately 0.4km west-southwest of the Site.

12th December 1940

1No. HE bomb fell on land off Townfield Lane, approximately 20m north-northeast of the Site. This was recorded as an UXB.

1st March 1941

4No. HE bombs fell on land south of the Meon Valley railway line and Park Place, on and within 0.1km east of the Site.

11th March 1941

1No. HE bomb fell on land at Cold Harbour Farm, Wickham, approximately 0.3km north-northwest of the Site.

8th April 1941

Several hundred IBs fell on land between Webb's Land Farm and Wickham along the Meon Valley line, on and within 0.4km east of the Site.

21st September 1941

2No. HE bombs fell on fields northwest of Titchfield Lane, between approximately 0.2km and 0.3km west-northwest of the Site.

22nd June 1942

1No. HE bomb fell on Blind Lane, Wickham, approximately 0.4km northeast of the Site.

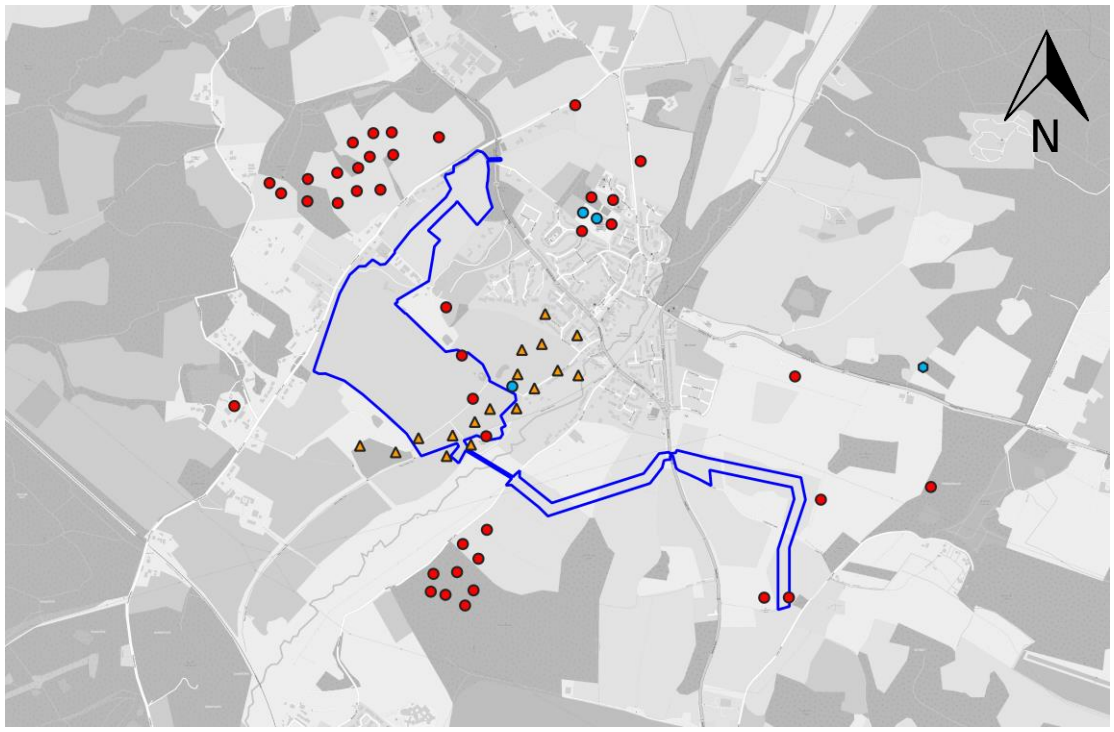
1No. HE bomb fell on Mill Lane, Wickham, approximately 0.5km east of the Site.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R8-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the Site

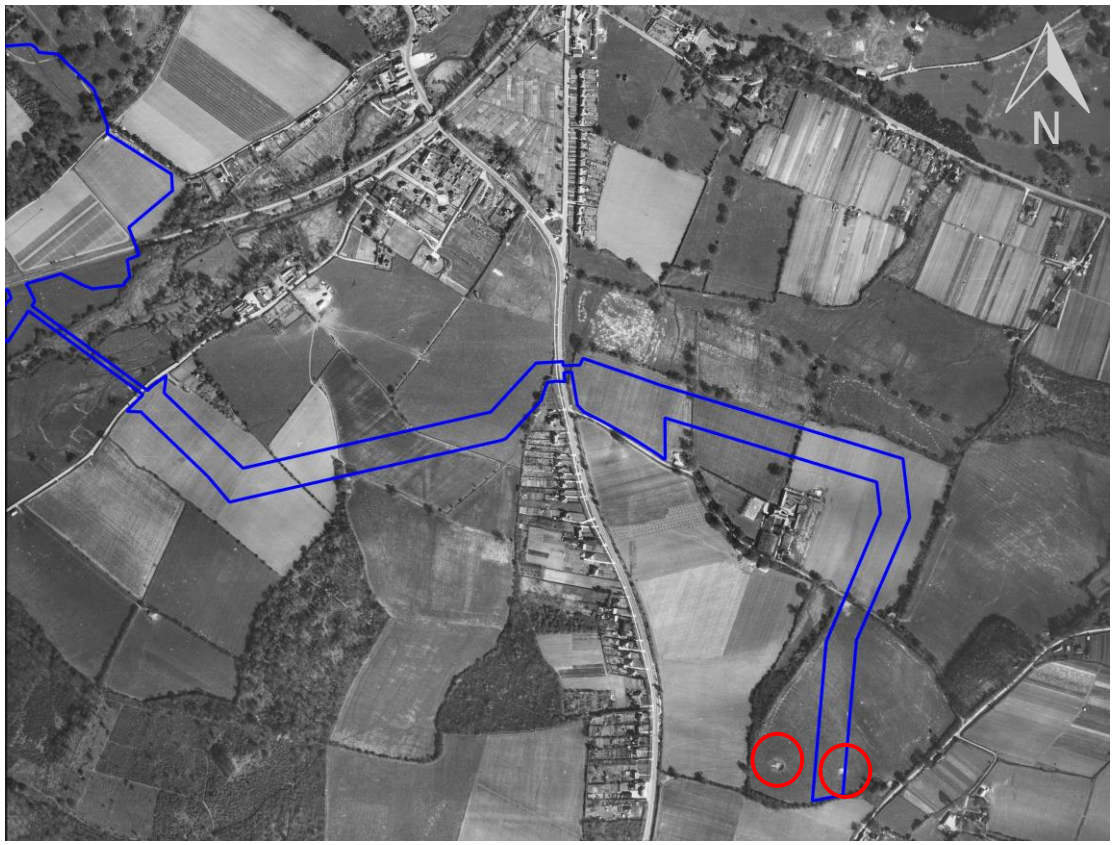


Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB	IBs

Plate 2 is an aerial photograph of the eastern part of the Site dated the 19th April 1946. 2No. bomb craters have been identified, including 1No. on the Site.

Plate 2 Aerial photograph of the eastern part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible bomb craters

Plate 2 is an aerial photograph of the western part of the Site dated the 19th April 1946. No bomb damage or cratering has been identified on this part of the Site.

Plate 3 Aerial photograph of the western part of the Site, 19th April 1946



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

Records have been found indicating that 4No. HE bombs and several IBs fell on the Site during WWII and exploded. IBs had a low HE content and were not designed to penetrate the ground (see Appendix 1).

No further bombing and no significant bomb damage has been identified on the Site on historical aerial photography.

Given the isolated nature of the incidents, infrequency of air raids in the area, and the low localised bombing density, it is considered unlikely that an UXB would have fallen on and the Site and been missed.

[redacted] is not considered to provide a source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of River Terrace Deposits of gravel, sand and silt, overlying clay, silt, and sands of the London Clay Formation and Wittering Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 1m of topsoil, over 2m of silty sand, overlying more than 20m of clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	3.0m
	250kg	6.0m
	500kg	11.0m

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place on or in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

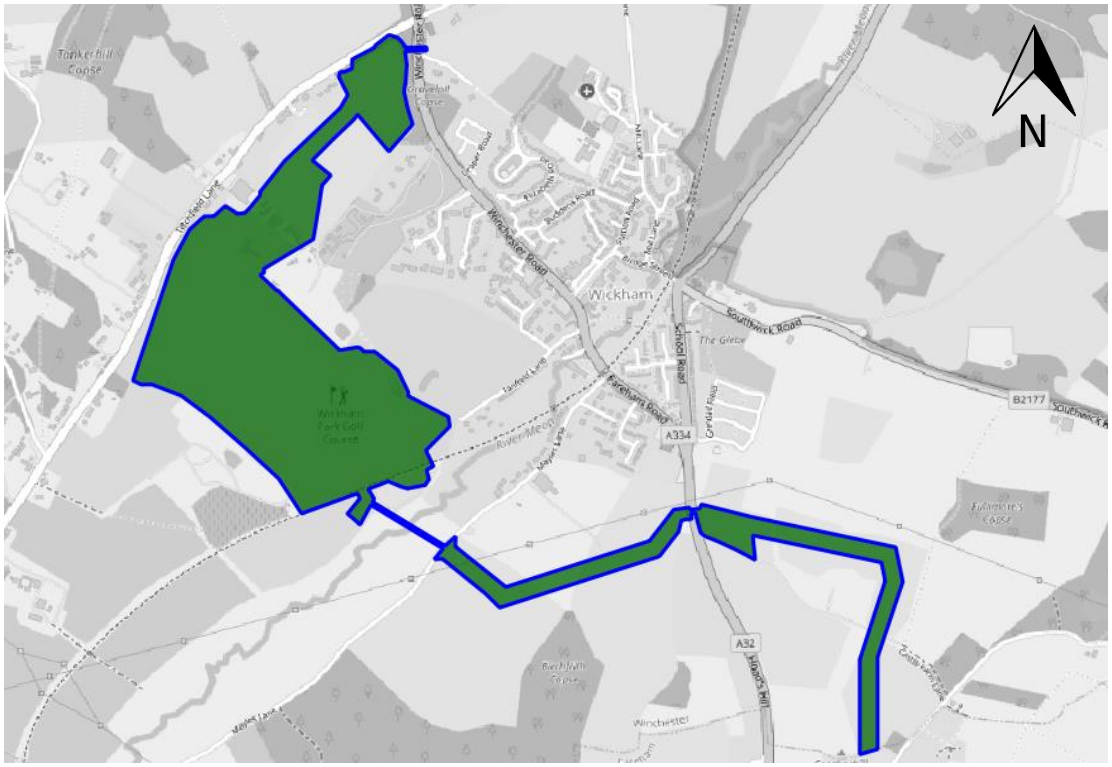
Records have been found indicating that 4No. HE bombs and several IBs fell on the Site and exploded during WWII.

No further bombing and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R8-MAP01-A.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: UXO awareness briefing is recommended for all staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – given the history of military activity in the vicinity of the Site, it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

A formal UXO awareness briefing should ensure that those involved in intrusive works take appropriate action if a suspect item is uncovered. The briefing can be given to all site workers, but the aim is to provide the client's key staff with the tools to provide the same induction to new staff without the UXO specialist's attendance.

The briefing will offer some recognition skills for typical UXO, and suitably sensitise those involved in excavation to be vigilant.

The induction materials are provided as a file containing both hard and electronic copies with additional information and resources such as UXO awareness posters, ordnance data sheets and emergency contact cards for staff awareness.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or have questions, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

APPENDICES

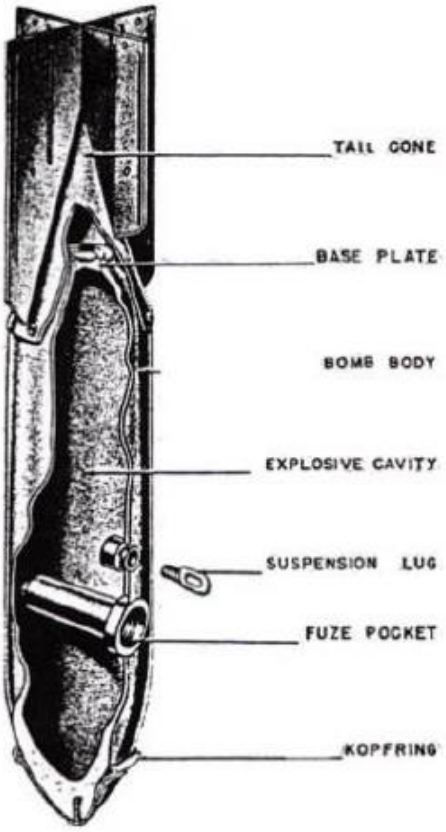
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



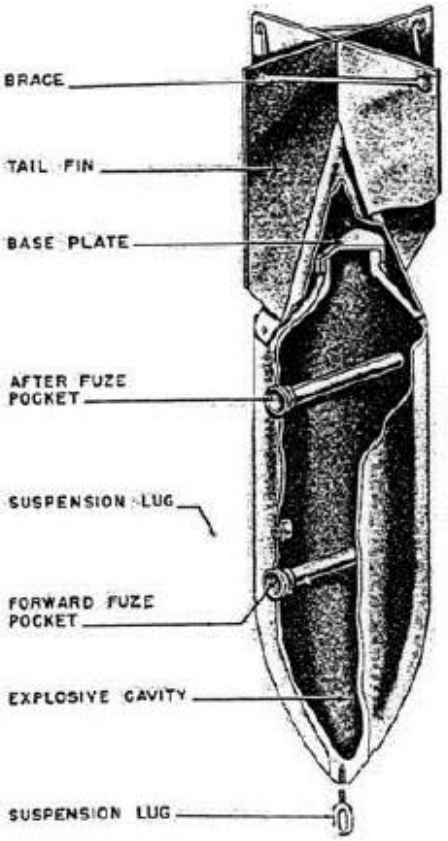




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



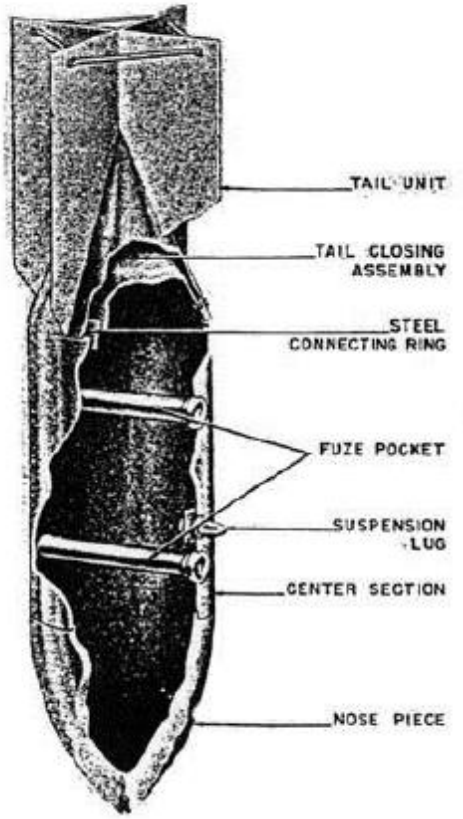




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



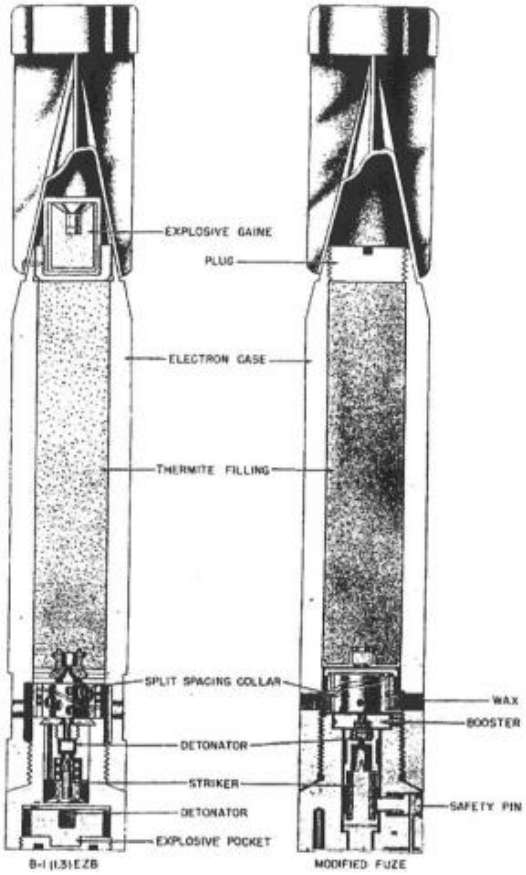




Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 1kg

Variants	6
Body Dimensions	350mm x 50mm (13.8" x 1.97")
Weight	1kg & 1.3kg (2.2lbs & 2.86lbs)
Charge Weight	8 -15 gm (0.28 – 0.53 oz) in models with Nitropenta explosive. No charge in B-1 & B-1.3 E types.
Fuze	Impact fuze with safety plug
Composition	Sheet steel
Description	The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze. The after body is tapered to receive the sheet metal, three-fined drum-shrouded tail assembly. The bomb is unpainted magnesium; the tail is dark green.
Function	Dropped in clusters against industrial and commercial targets to start conflagrations.







Information Data Sheet

Category Bomb (Luftwaffe)
Type Brandbombe (Incendiary Bomb) 2kg

Variants 2

Body Dimensions 525mm x 50mm (20.67" x 1.97")

Weight 2kg & 2.2kg (4.4lbs & 4.85lbs)

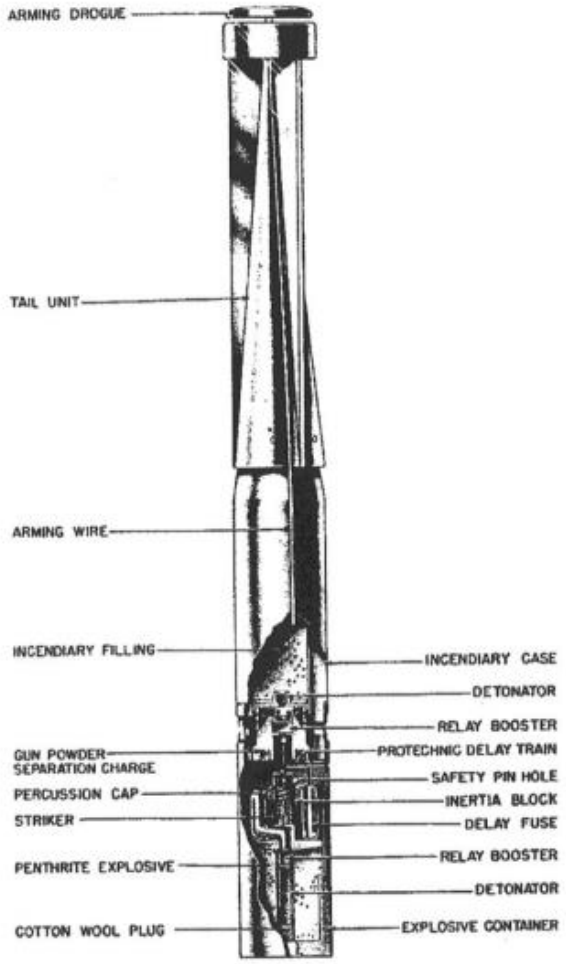
Charge Weight 60g (0.13lbs)

Fuze Impact fuze with screw impact

Composition Sheet steel

Description Steel cylinder. Body originally painted green with black explosive section and grey tail.

Function Dropped in clusters against industrial and commercial targets to start conflagrations. When dropped from 2000m could penetrate iron-concrete roofing.







Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.





Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

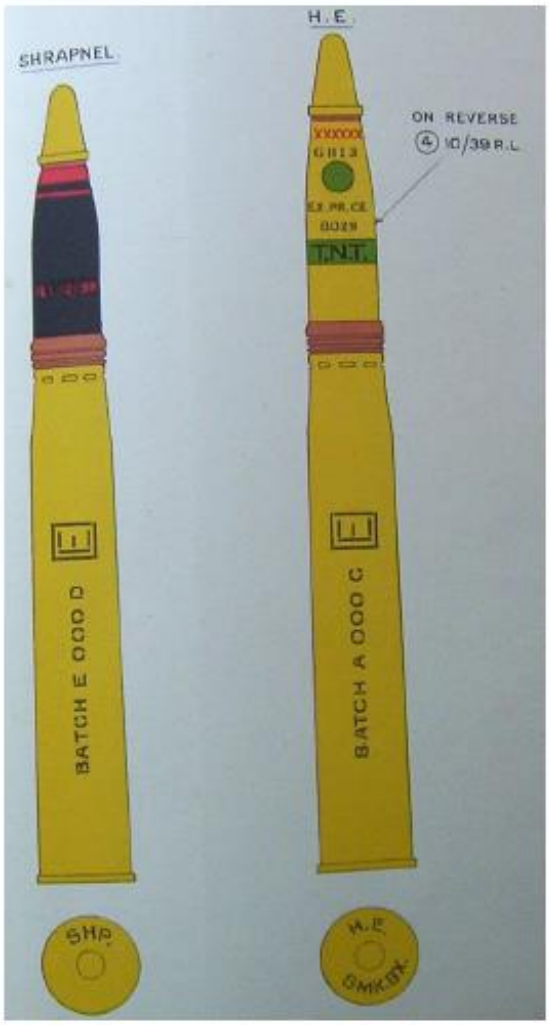
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

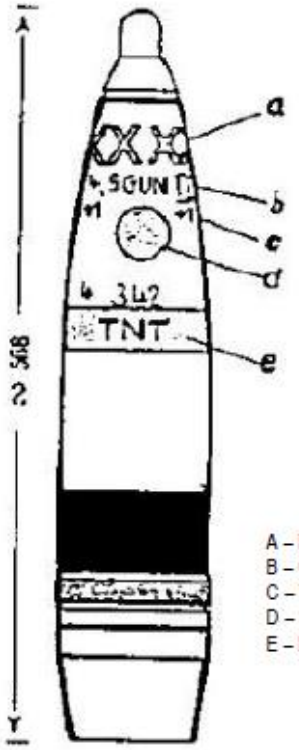
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

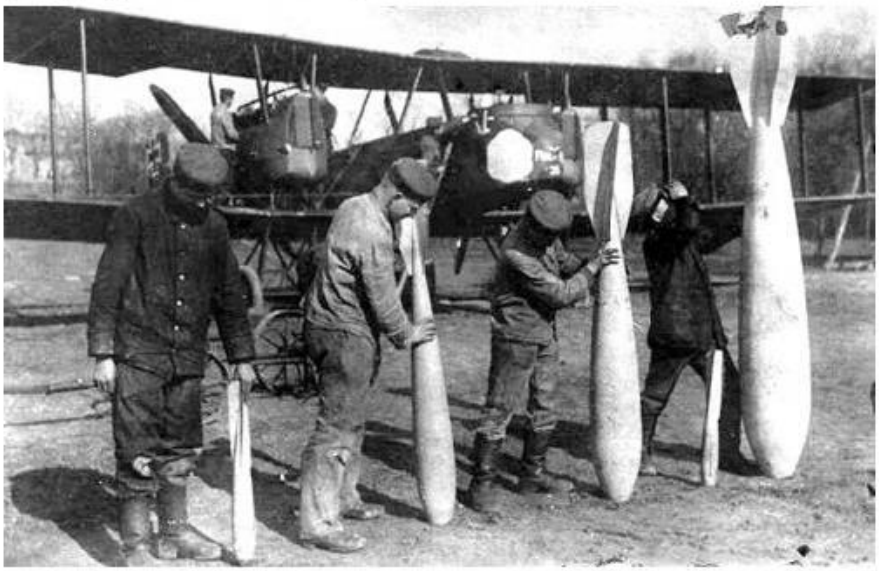
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Leete J, In Time of War: Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War 1939 – 45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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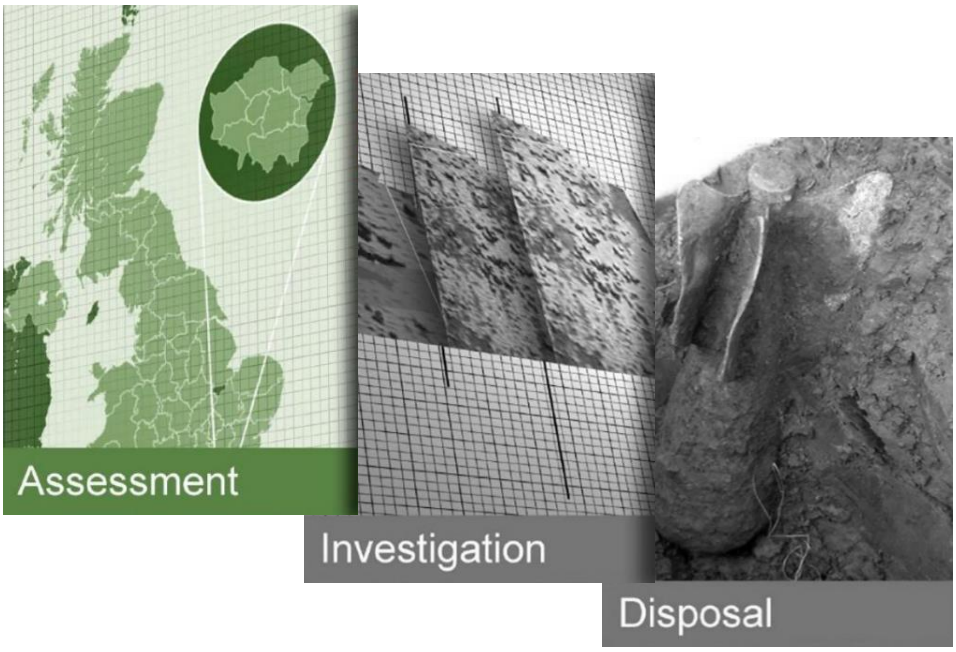
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- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R7**
Revision	**A**
Project Title	**H Site**
Client	**Southern Water**
Date	**18th March 2024**

Drafted by	**William Holford**
Checked by	**James Major**
Authorised by	**Stefan Lang**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: An UXO awareness briefing is recommended for staff involved in excavations.

UXO hazard assessment

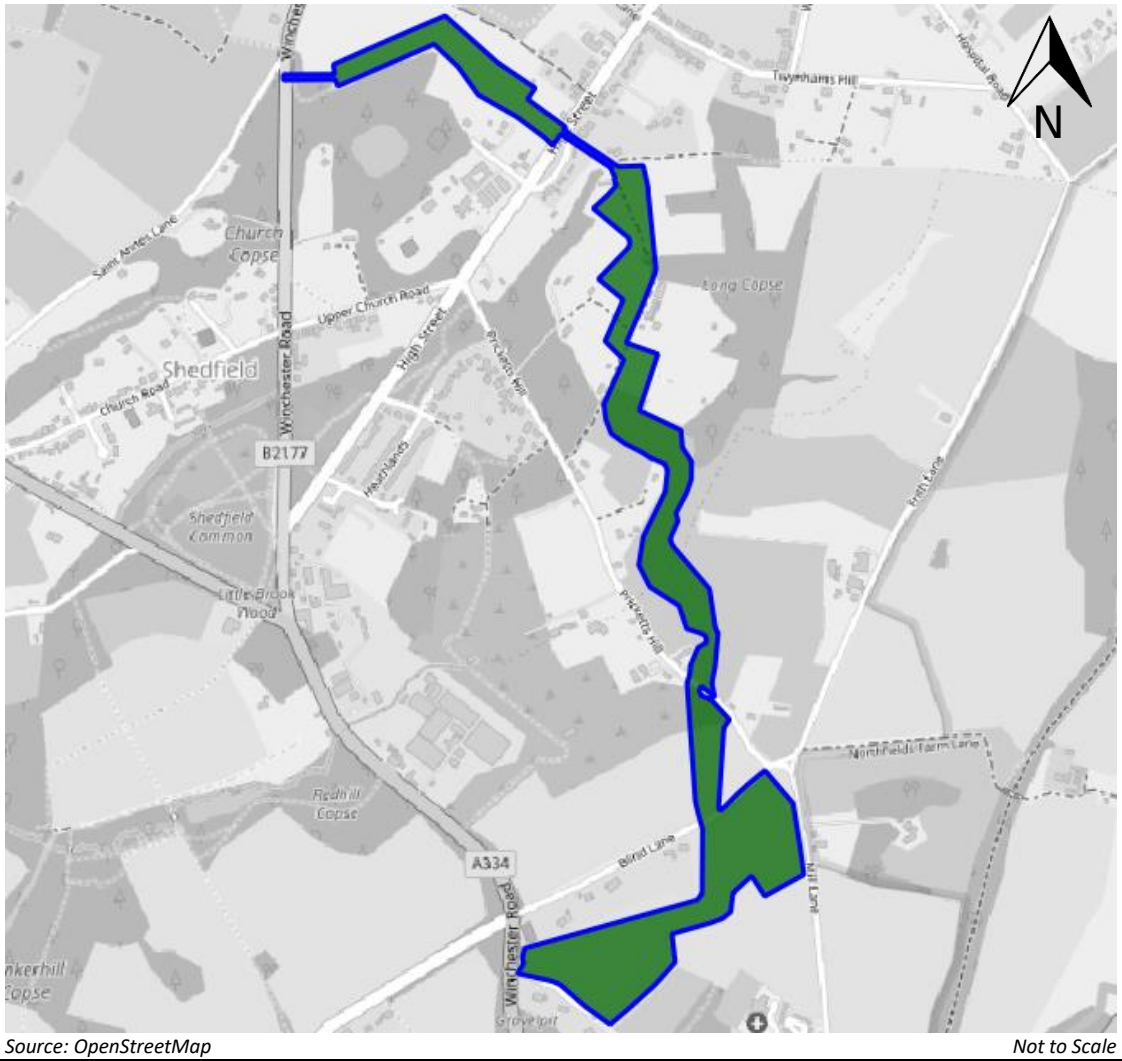
During World War Two (WWII), 1No. Hawker Hurricane fighter aircraft crashed on the Site. The fighter aircraft crash is not considered to provide a significant source of UXO hazard to the Site.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R7-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- On the 1st November 1940, 1No. Hawker Hurricane fighter aircraft crashed on the Site. Parts of the aircraft were subsequently recovered by salvage teams.
- During 1944, the Site was located within Marshalling Area 'A'. Troops, equipment, and supplies were concentrated in marshalling areas prior to the 'D-Day' landings in occupied France.
- In 2019, the Hawker Hurricane crash, on the Site, was investigated by archaeologists and additional inert items recovered.
- During WWII the main strategic targets in the vicinity of the Site included Royal Air Force (RAF) Soberton, aircraft manufacturing and engineering works, military barracks and camps, and Southern Railway lines.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 20m east of the Site.
- There were 10No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	**Low**
	HDD	1	1	1	1	4	4	**Low**
Other UXO	Excavations	1	1	1	1	4	4	**Low**
	HDD	1	1	1	1	3	3	**Low**
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

What do I do next?

If you require a quote for an awareness briefing or have any comments, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R7-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
ELG	Emergency Landing Ground
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
HQ	Headquarters
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RAF	Royal Air Force
RE	Royal Engineers
RLG	Reserve Landing Ground
RNAS	Royal Naval Air Station
SAA	Small Arms Ammunition
UK	United Kingdom
US	United States
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route of approximately 2.8km between Winchester Road and Gravelpit Copse, in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Archives and Local Studies, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

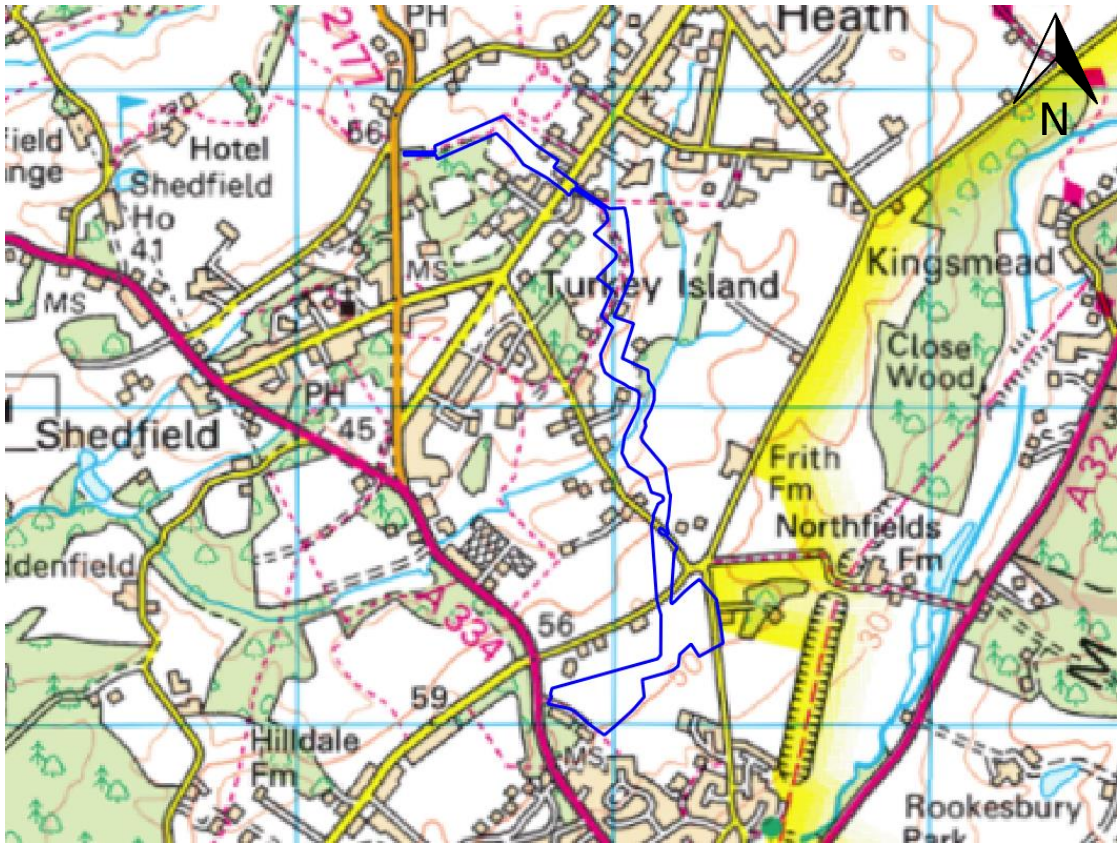
2.1 Site location

The Site commences at Winchester Road (SU 563138) and terminates at Gravelpit Copse (SU 568120).

It comprises roadways and agricultural land. It is bounded to the north by roadways, residential buildings, and agricultural land, to the east by agricultural buildings and land, to the south by woodland and agricultural land, and to the west by Winchester Road and agricultural buildings and land.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity on and in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, see Appendix 2.1. Alternatively, follow the link below:

- Aircraft Crashes

Records indicate that during WWII, 2No. aircraft crashed on and in the vicinity of the Site. Details are provided below.

1st November 1940

1No. Hawker Hurricane Mk I (N2608, AK-F) fighter aircraft crashed on a field between Frith Farm and Prickett's Hill (SU 571128), on the Site. The aircraft was on an air defence mission and was armed with 8No. .303" machine guns.

After the crash, a salvage team recovered the majority of the aircraft's wreckage, including the engine block. The aircraft's impact crater was subsequently backfilled and reverted to agricultural use.

In 2019, the crash was investigated by archaeologists and further inert items were recovered, including cockpit instruments, identification plates, and the aircraft's control column.

After the excavation, the crash was returned to agricultural use.

WWII

1No. Supermarine Spitfire fighter aircraft crashed on Station Field, Wickham, approximately 0.5km southeast of the Site. The aircraft was subsequently recovered by a salvage team.

Potential UXO hazard

During WWII, 1No. Hawker Hurricane Mk I (N2608, AK-F) crashed on the Site. Small Arms Ammunition (SAA) from the aircraft's guns may have been scattered over a wide area, including the Site.

The majority of SAA associated with the crash is likely to have been encountered during subsequent salvage and archaeological activities. The potential for SAA to remain in situ on the Site cannot be discounted. SAA is not considered to provide a significant source of UXO hazard to the Site (see Appendix 1).

All crashed military aircraft within the mainland and coastal waters are controlled sites under the Protection of Military Remains Act 1986. A license is required to investigate the location of any known aircraft crash sites and the appropriate authorities should be contacted upon the discovery of items related to an aircraft crash.

The potential for encounter with radiological hazards (e.g., radium-luminised dials) also cannot be totally discounted.

Aircraft crashes are not considered to provide a significant source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.2.1 Anti-Aircraft (AA) guns

During WWI there were 6No. AA batteries recorded within 10km of the Site. The nearest was located at Titchfield (SU 544057), approximately 6.5km south-southwest of the Site. It was armed with 1No. 18-pounder (-pdr) gun.

During WWII there were 10No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Shedfield Common (SU 561131), approximately 0.5km west of the Site (see Plate 2). Its armament is unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

11th September 1940

1No. AA shell fell on a garden in Mill Lane, approximately 70m east of the Site. It was recorded as an Unexploded AA (UXAA) shell.

3rd December 1940

3No. AA shells fell on a field at Budden's Farm, approximately 0.5km southeast of the Site. 1No. of these was recorded as an UXAA shell.

27th December 1940

1No. AA shell fell on open ground at Sandy Hill, approximately 0.2km north of the Site. It was recorded as an UXAA shell.

11th June 1942

2No. AA shells fell on a chicken run in Blind Lane, approximately 30m north of the Site.

26th June 1942

1No. AA shell fell on a garden in Winter's Road, approximately 0.5km northeast of the Site. It was recorded as an UXAA shell.

18th August 1942

1No. AA shell fell on a field at Budden's Farm, approximately 0.4km south of the Site. It was recorded as an UXAA shell.

25th February 1944

1No. AA shell fell on Budden's Farm, approximately 0.5km southeast of the Site. It was recorded as an UXAA shell.

26th March 1944

1No. AA shell fell on Titchfield Lane, on the Site. It was recorded as an UXAA shell.

26th July 1944

1No. AA shell fell on a field at Park Place, approximately 0.2km southwest of the Site. It was recorded as an UXAA shell.

Potential UXO hazard

Given the number of AA batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.2.2 Bombing decoys

The nearest recorded bombing decoy was located on land east of Durley (SU 534162), approximately 3.6km northwest of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Naval Air Station (RNAS) Lee-on-Solent, approximately 10km south of the Site. The airfield opened in 1917 and was used primarily for training with seaplanes.

After WWI, it remained in use for training purposes. It is currently a civilian airfield known as Solent Airport Daedalus.

During WWII, the nearest operational airfield was RAF Soberton, approximately 4.6km northeast of the Site. The airfield opened in 1940. It was designated as a Reserve Landing Ground (RLG) for other airfields in the region, in the event that they should become unusable. It was also used as an Emergency Landing Ground (ELG) for aircraft in distress.

After WWII, RAF Soberton closed and returned to agricultural use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots, or munitions disposal areas on or in close proximity to the Site have been found.

3.5 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

3.6 Other military establishments

The following other military establishments have been identified in the vicinity of the Site.

3.6.1 Marshalling Areas

During 1944, troops, equipment, and supplies were concentrated within designated marshalling areas across the southern United Kingdom (UK) in preparation for the 'D-Day' landings in occupied France. The Site was located within Marshalling Area 'A'.

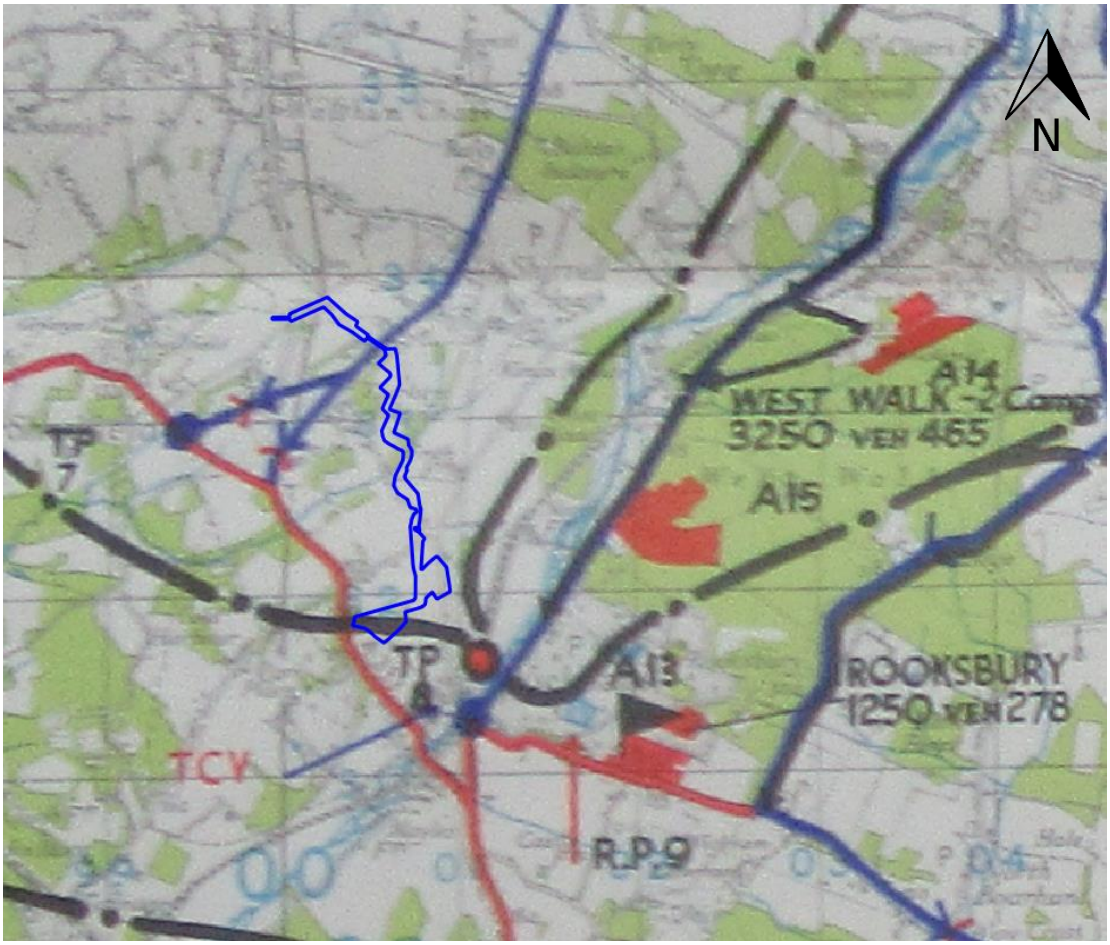
Records indicate that Sub-Area 'Y' of the marshalling area encroached on the southern part of the Site. Additionally, roads on and in close proximity to the Site were designated as controlled routes for use during the build-up and subsequent operations.

No records have been found to indicate that any significant establishments associated with the marshalling area were located on the Site. The nearest camp was located at West Walk, approximately 0.9km east of the Site. The camp accommodated elements of the 3rd and 53rd (Welsh) Divisions, the 3rd Canadian Infantry Division, and the 2nd Canadian Armoured Brigade.

Anecdotal evidence indicates that United States (US) Army forces were accommodated at Shedfield House (SU 553136), approximately 0.9km southwest of the Site, and established a greasing depot for waterproofing activities on Shedfield Common (SU 562130), approximately 0.7km southwest of the Site.

Figure 2 is a map of Marshalling Area 'A', dated the 1st May 1944. The sub-area boundaries, Headquarters (HQ) of Sub-Area 'Y', 3No. marshalling camps, several traffic routes, 2No. traffic posts, and 1No. detention point have been identified.

Figure 2 Map of Marshalling Area 'A', 1st May 1944



Source: The National Archives *Not to Scale*

Legend	Site boundary	Sub-Area boundary	Sub-Area Headquarters
	Marshalling camp	Traffic route	
	Traffic post	Detention point	

From September 1944, the marshalling areas were no longer required. Their associated military establishments were subsequently dismantled as the 'D-Day' landings had finished.

Marshalling areas are not considered to provide a significant source of UXO hazard to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.3 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids on Hampshire began in the summer of 1940 and continued until the end of WWII. Over one third of the total number of bombs fell on Southampton, approximately 12km west-southwest of the Site, and Portsmouth, approximately 14km southeast of the Site.

Rural areas remained at risk of bombing. This often comprised 'tip and run' or opportunity attacks by small groups of aircraft operating for harassment effect. Other bombs were jettisoned by aircraft en route to or returning from targets elsewhere in the UK.

From 1944, Hampshire was also at risk from the Pilotless Aircraft (V1) offensive. These weapons were highly inaccurate and often missed their intended targets by several km.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precautions (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including RAF Soberton, aircraft manufacturing and engineering works, military barracks and camps, and Southern Railway lines.

The nearest identified Luftwaffe target was Fareham Railway Bridge, approximately 5km south of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for V1s and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Havant & Waterloo UD	375	39	9	423	35.0
Fareham UD	447	11	18	476	25.9
Petersfield RD	457	9	19	485	8.6
Winchester RD	795	19	26	840	7.6
Alton RD	472	2	13	487	7.4

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section. Appendix 5 provides further recorded bombing incidents in the vicinity of the Site.

27th August 1940

4No. High Explosive (HE) bombs and 2No. IBs fell on Turkey Island, Shedfield, approximately 0.2km west-southwest of the Site.

30th October 1940

HE bombs (number unspecified) fell on Wickham, approximately 0.2km southeast of the Site. 2No. of these were recorded as UXBs.

18th November 1940

13No. HE bombs fell on Shirrell Heath, within approximately 0.3km north of the Site.

22nd June 1942

1No. HE bomb fell on Blind Lane, Wickham, approximately 20m west of the Site.

1No. HE bomb fell on Wickham, approximately 0.2km south-southeast of the Site.

Date Unspecified

1No. HE bomb fell on Mill Lane, approximately 20m east of the Site.

1No. HE bomb fell on a field east of Turkey Island, approximately 0.1km west of the Site.

1No. HE bomb fell on Shirrell Copse, approximately 0.1km west-northwest of the Site.

1No. HE bomb fell on a field southwest of Sandy Hills House, approximately 0.2km west of the Site.

1No. HE bomb fell on a field northwest of Titchfield Lane, approximately 0.3km west-northwest of the Site.

1No. HE bomb fell on New Place Preparatory School, approximately 0.3km southwest of the Site.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R7-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the Site



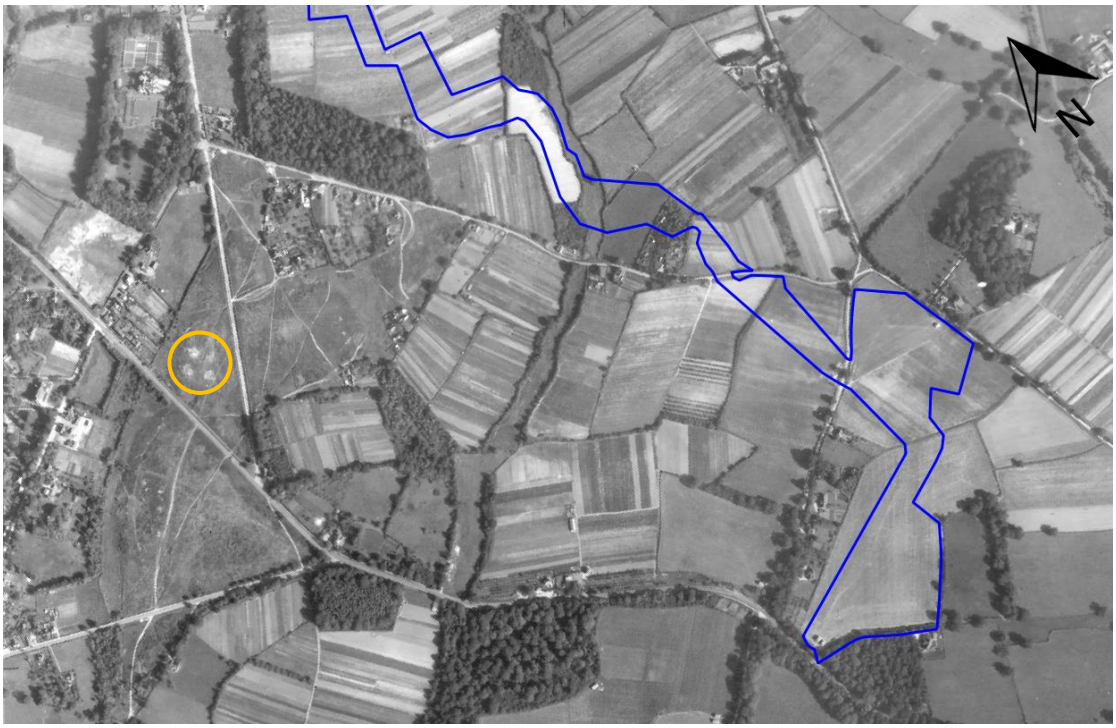
Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB	IBs

Plate 2 is an aerial photograph of the southern part of the Site, dated the 7th October 1946. No bomb damage or cratering has been identified on or in the vicinity of the Site.

The remains of the Shedfield Common HAA battery have been identified (see Section 3.2.1).

Plate 2 Aerial photograph of the southern part of the Site, 7th October 1946

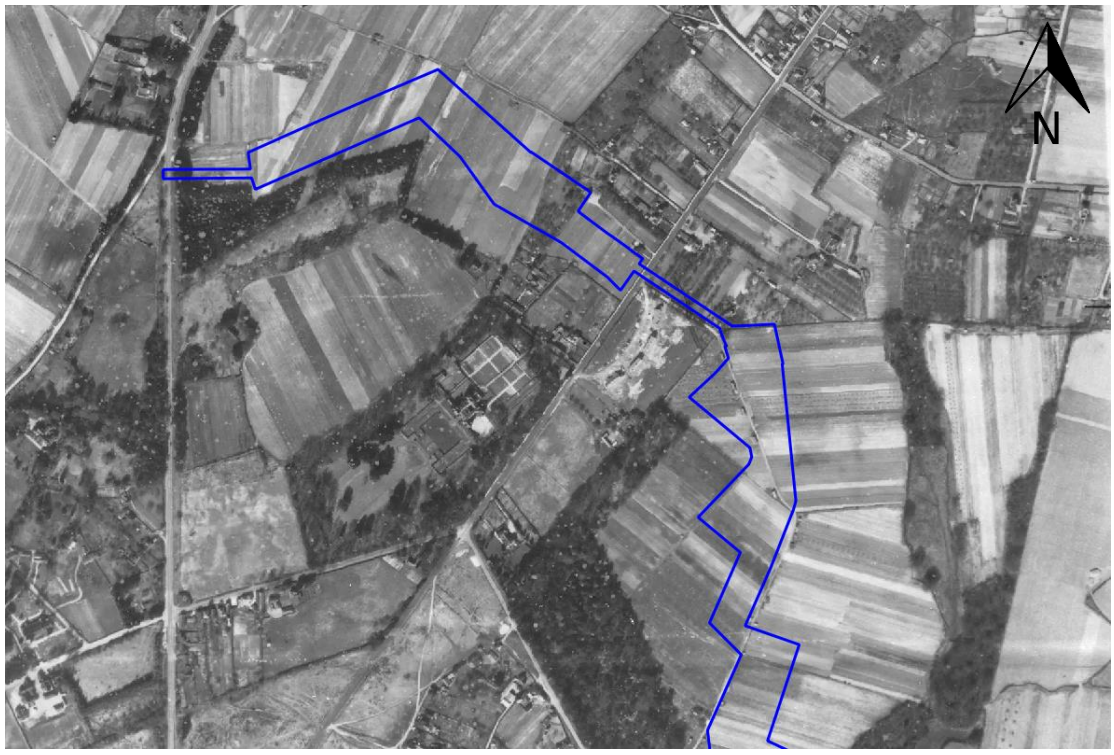


Source: Historic England *Not to Scale*

Legend	Site boundary	Shedfield Common HAA Battery

Plate 3 is an aerial photograph of the northern part of the Site, dated the 13th April 1947. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 3 Aerial photograph of the northern part of the Site, 13th April 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of Made Ground and open ground, over clays to gravels, overlying clays and sands of the London Clay and Wittering Formations.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 1m of topsoil (modelled as soft clay), over 1m of stiff clay and gravel, over 12m of sand, over 4m of stiff clay, over 1m of sand, overlying more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	4.0m
	250kg	5.0m
	500kg	7.5m

Where Made Ground was present, the estimated average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

During WWII, 1No. Hawker Hurricane fighter aircraft crashed on the Site. The fighter aircraft crash is not considered to provide a significant source of UXO hazard to the Site.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R7-MAP01-A.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m bgl and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: An UXO awareness briefing is recommend for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**UXO awareness briefing** – it is recommended that a formal UXO awareness briefing is provided to staff involved in excavations.
HDD		**Proceed with works**

In summary, it is recommended that staff involved in excavations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is recommendation that all staff involved in excavations are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you require a quote for an awareness briefing or have any comments, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Small Arms Ammunition
Type Various



Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.

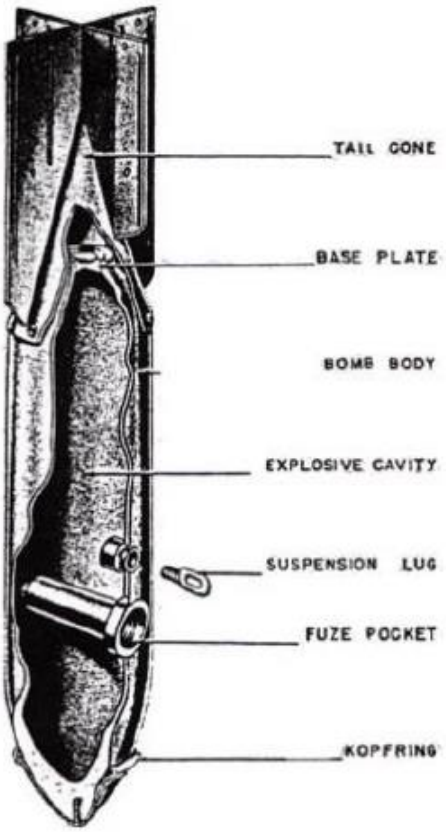




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



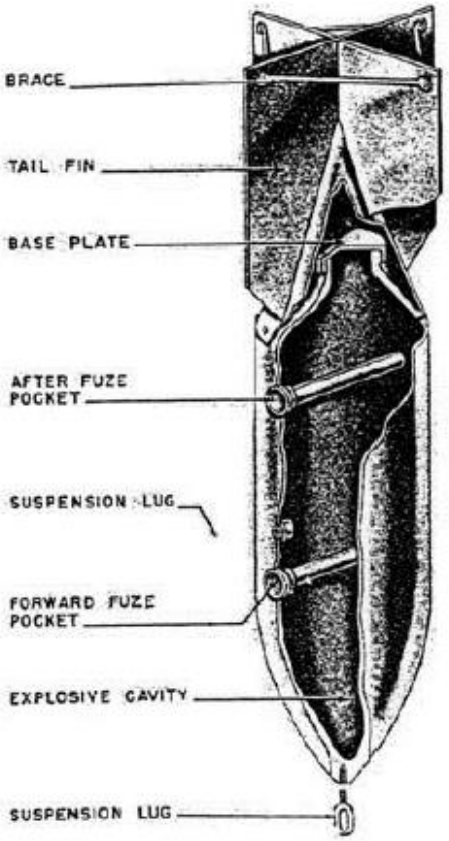




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



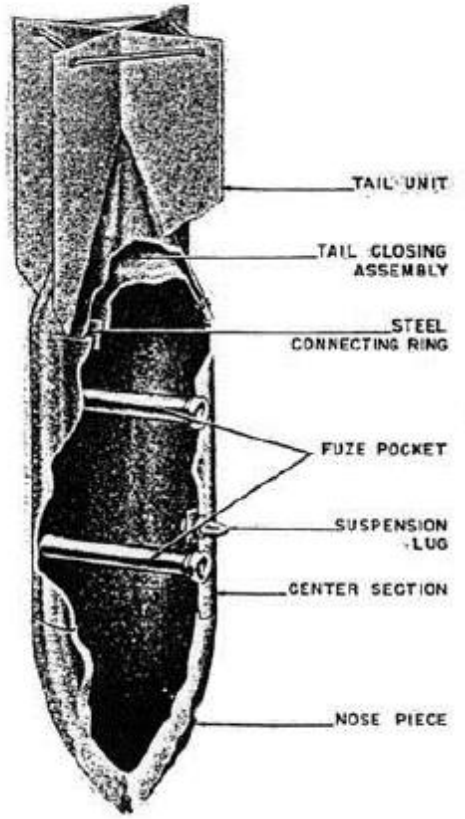




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.



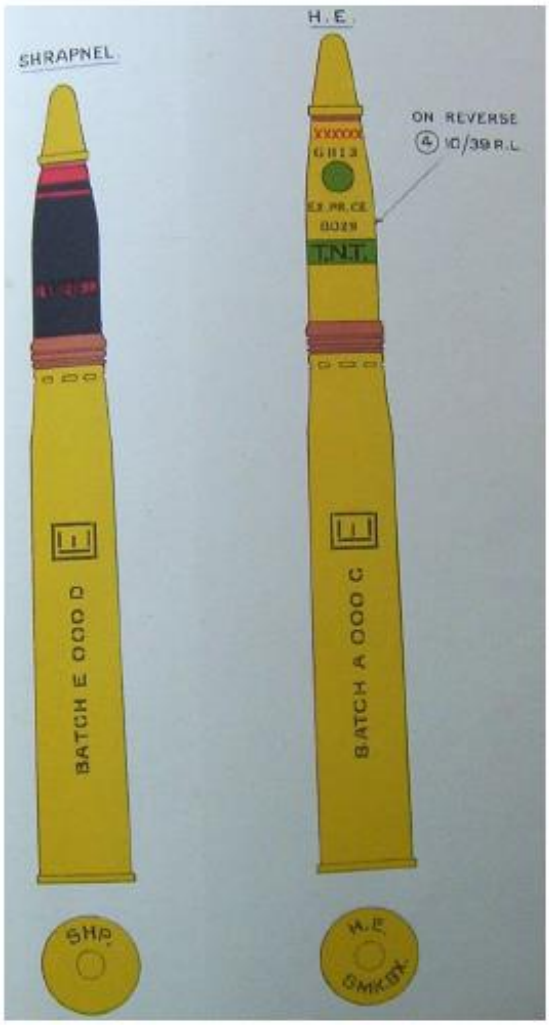




Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

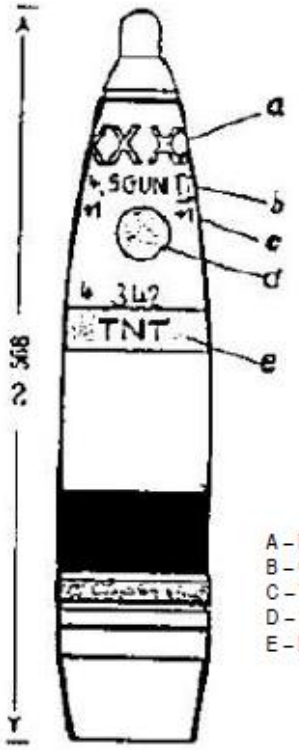
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 Aircraft crashes

Information Data Sheet

Category Aircraft Crashes

Description:

Military aircraft operations will occasionally result in aircraft crashes, and they were especially common during the exigencies of wartime. Collisions, damage sustained during operational duty, pilot error, and adverse weather conditions were all causes for crashes.

The nature of aircraft crashes means that debris was often scattered over a wide area around the crash site, sometimes up to a distance of two miles.



Wreckage of a B-24 Flying Fortress bomber aircraft crash, WWII

Hazard:

Whether an aircraft crash provides a potential source of Unexploded Ordnance (UXO) hazard is largely dependent on the type of aircraft that crashed, its operational status, its ordnance load, and any efforts made to clear up the crash site.

Small Arms Ammunition (SAA) from the aircraft's defensive guns is the most common source of ordnance associated with aircraft crashes as it may scatter over a wide area. Some later aircraft designs were armed with 20mm cannons, the shells of which have High Explosive (HE) content. 20mm HE cannon shells would constitute a potential UXO hazard, whereas SAA is less significant.

Bomber aircraft crashing with full or partial bomb loads provide a further potential hazard. If the crash site was inaccessible or remote it would commonly not be investigated during wartime. As such, Unexploded Bombs (UXBs) from the aircraft may remain around bomber aircraft crash sites.

Post-World War Two (WWII) crash sites are typically more thoroughly cleared of debris and residues than those which occurred during wartime.

The Ministry of Defence (MoD) advises that if crashed aircraft are found, the safest policy is to leave them alone where possible. Unless disturbed there is no statutory requirement for the MoD to clear such sites. It should be noted that in some cases where a fatal crash site is located, the disturbance of the site may be prohibited due to its status as a war grave.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

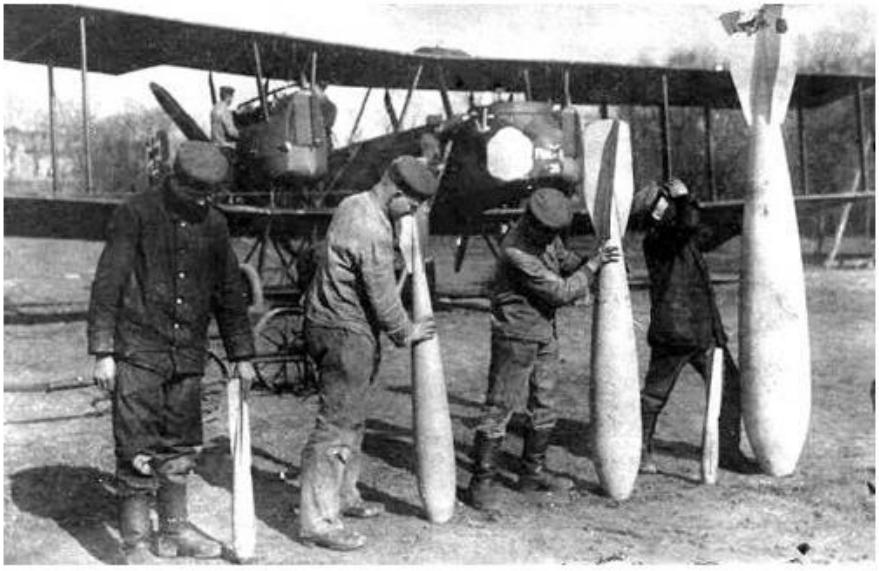
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.3 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.4 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 [redacted] incident list

27th August 1940

4No. HE bombs and 2No. IBs fell on Turkey Island, Shedfield, approximately 0.2km west-southwest of the Site.

30th October 1940

HE bombs (number unspecified) fell on Wickham, approximately 0.2km southeast of the Site. 2No. of these were recorded as UXBs.

18th November 1940

13No. HE bombs fell on Shirrell Heath, within approximately 0.3km north of the Site.

12No. HE bombs fell on Shirrell Heath, within approximately 0.5km east-northeast of the Site.

1st March 1941

5No. HE bombs fell on Wickham, approximately 0.5km south-southwest of the Site.

8th April 1941

Several IBs fell on Wickham, approximately 0.5km south of the Site.

20th September 1941

2No. HE bombs fell on fields northwest of Titchfield Lane, approximately 0.5km west of the Site.

22nd June 1942

1No. HE bomb fell on Blind Lane, Wickham, approximately 20m west of the Site.

1No. HE bomb fell on Wickham, approximately 0.2km south-southeast of the Site.

1No. HE bomb fell on a field south of Solomon's Lane, approximately 0.5km north of the Site.

Date Unspecified

1No. HE bomb fell on Mill Lane, approximately 20m east of the Site.

1No. HE bomb fell on a field east of Turkey Island, approximately 0.1km west of the Site.

1No. HE bomb fell on Shirrell Copse, approximately 0.1km west-northwest of the Site.

1No. HE bomb fell on a field southwest of Sandy Hills House, approximately 0.2km west of the Site.

1No. HE bomb fell on a field northwest of Titchfield Lane, approximately 0.3km west-northwest of the Site.

1No. HE bomb fell on New Place Preparatory School, approximately 0.3km southwest of the Site.

HE bombs (number unspecified) fell on Frith Lane, approximately 0.4km east of the Site.

1No. HE bomb fell on a field west of Winchester Road, approximately 0.5km north-northwest of the Site.

Appendix 6 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Leete J, In Time of War: Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War, 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 7 General Notes

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2. The report should not be used by third parties without prior consultation with Zetica Ltd. The copyright for this report remains with Zetica Ltd.
3. No part of this report may be reproduced, published or amended without prior written consent from Zetica Ltd.
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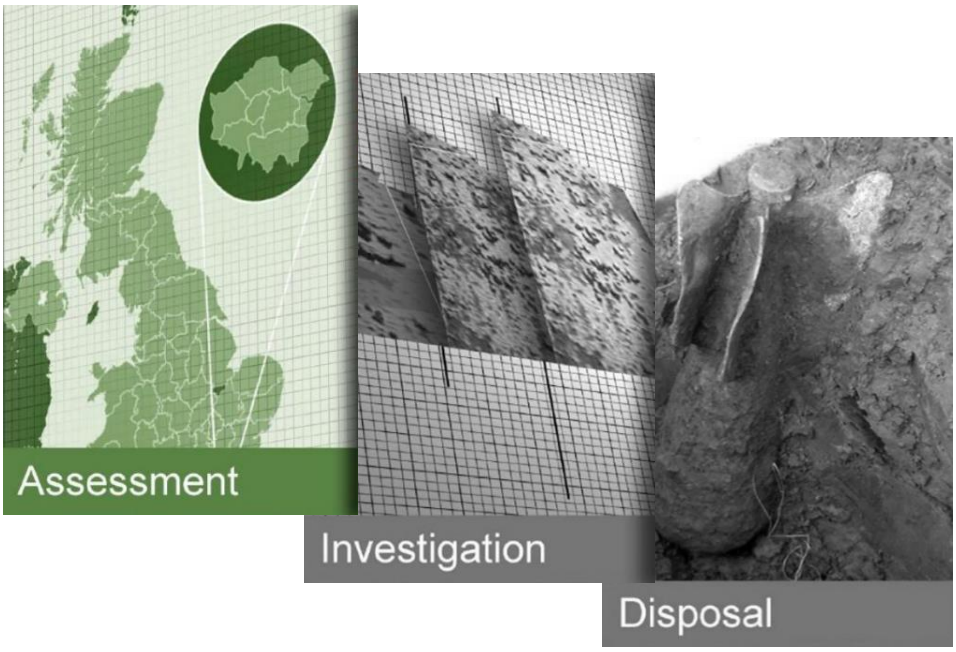
Established for over 32 years, Zetica's services include

- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]

zeticaUXO



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R6**
Revision	**A**
Project Title	**J Site**
Client	**Southern Water**
Date	**18th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

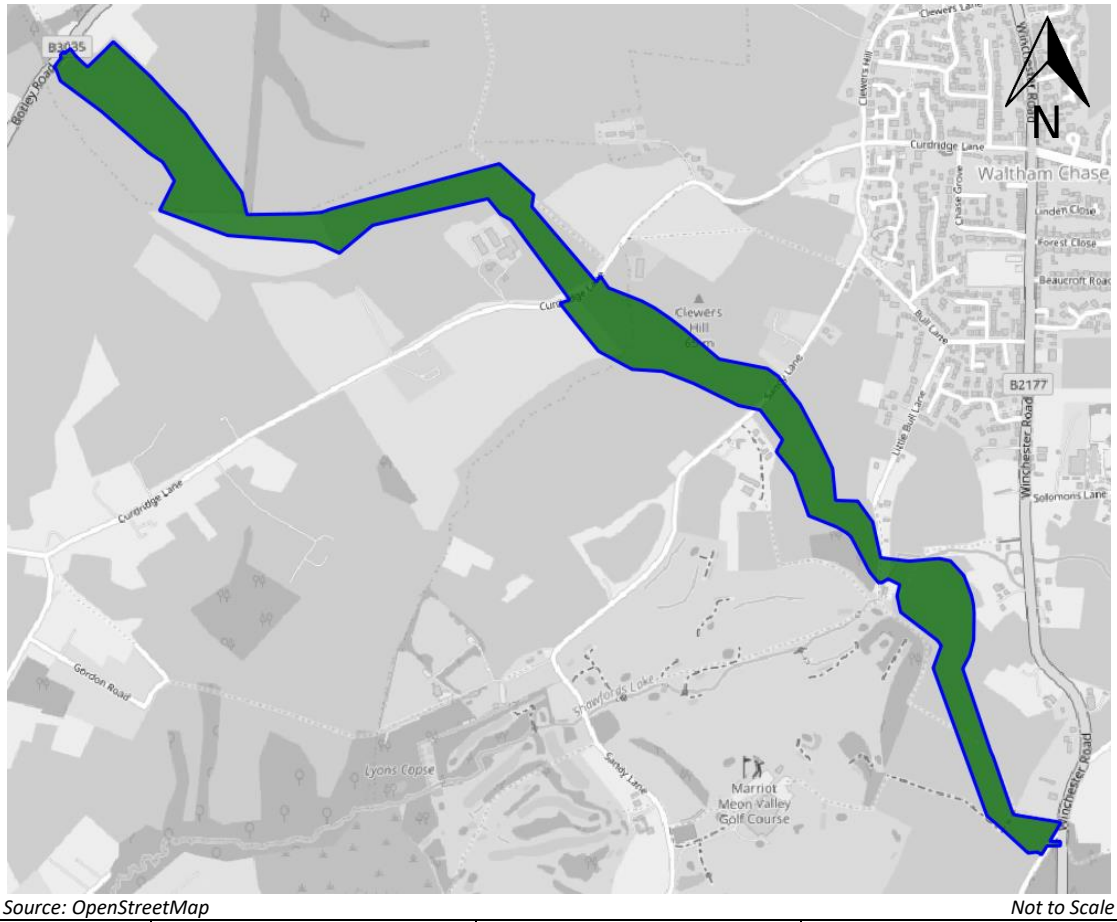
UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 3 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R6-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate
	High		Very High		Site boundary

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) or World War Two (WWII) have been found.

- During WWII the main strategic targets in the vicinity of the Site included military barracks and camps, and the Southern Railway network.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 0.1km southwest of the Site.
- There were 10No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	**Low**
	HDD	1	1	1	1	4	4	**Low**
Other UXO	Excavations	1	1	1	1	4	4	**Low**
	HDD	1	1	1	1	3	3	**Low**
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R6-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
AAP	Air Acceptance Park
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
DID	Direct Issue Depot
ELG	Emergency Landing Ground
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
QF	Quick Fire
QL	Quick Light
RAF	Royal Air Force
RE	Royal Engineers
RFC	Royal Flying Corps
RLG	Reserve Landing Ground
SF	Special Fire
UK	United Kingdom
US	United States
USNAS	United States Naval Air Service
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec on behalf of Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route of approximately 3.3km between Botley Road and Winchester Road, in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Archives and Local Studies, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

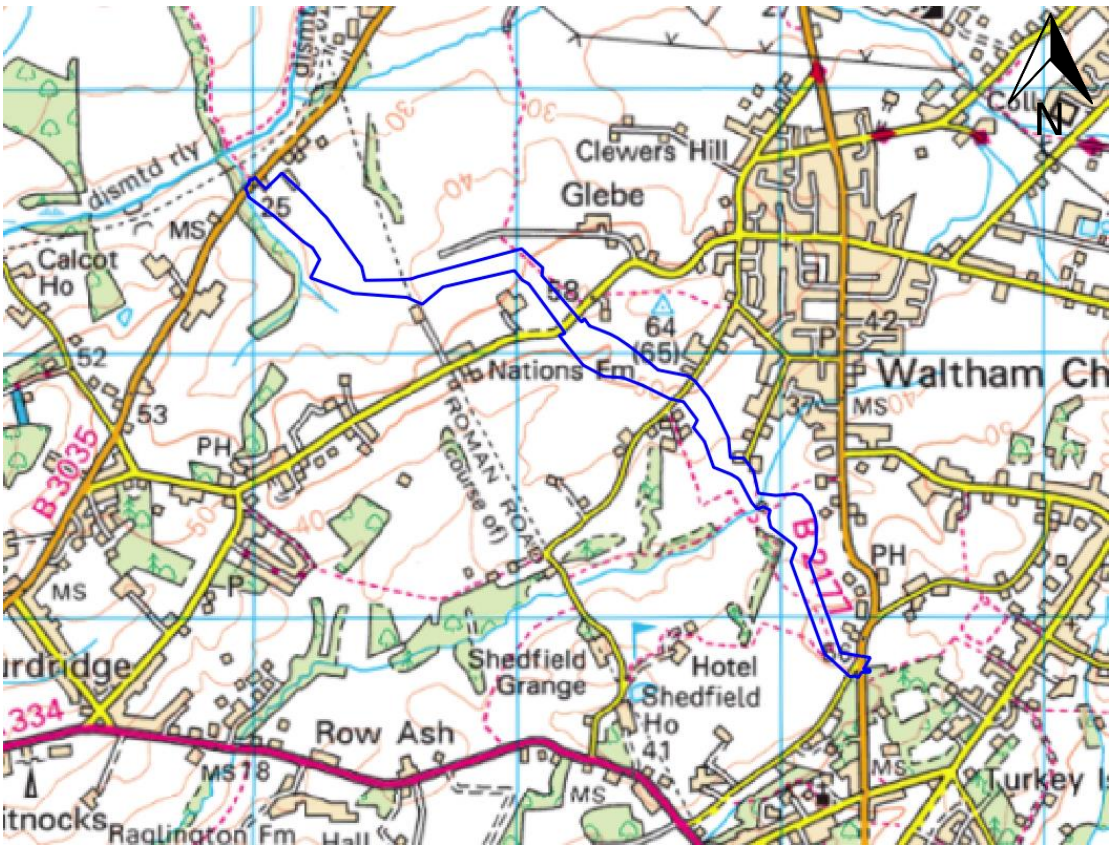
2 THE SITE

2.1 Site location

The Site commences at Botley Road (SU 539156) and terminates at Winchester Road (SU 563138). It comprises roadways and agricultural land. It is bounded to the north and south by roadways and agricultural buildings and land, to the east by Winchester Road, and to the west by Botley Road.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.1.1 Anti-Aircraft (AA) guns

During WWI there were 3No. AA batteries recorded within 10km of the Site. The nearest was located at Titchfield (SU 544057), approximately 8km south-southwest of the Site. It was armed with 1No. 18-pounder (-pdr) gun.

During WWII there were 10No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Shedfield Common (SU 561131), approximately 0.6km south-southeast of the Site. Its armament is unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

27th December 1940

1No. AA shell fell on open ground at Sandy Hill, approximately 0.3km northeast of the Site. It was recorded as an Unexploded AA (UXAA) shell.

22nd March 1941

1No. AA shell fell on Spencer Place, approximately 0.2km southwest of the Site. It was recorded as an UXAA shell.

10th April 1941

1No. AA shell fell on open ground near Butts Lane, approximately 50m northeast of the Site. It was recorded as an UXAA shell.

21st June 1942

1No. AA shell fell on a field at Harfield's Farm, approximately 0.1km northeast of the Site.

22nd June 1942

1No. AA shell fell on a field at Harfield's Farm, approximately 0.2km southwest of the Site.

Potential UXO hazard

Given the number of AA batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.1.2 Bombing decoys

The nearest recorded bombing decoy was located on land east of Durley (SU 534162), approximately 0.9km northwest of the Site. This was a combined Quick Light (QL), Quick Fire (QF), and Special Fire (SF) type decoy intended to divert enemy bombers from the Southampton city and docks. No records have been found to indicate that it was successfully bombed.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.2 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Flying Corps (RFC) Eastleigh, approximately 8.8km west of the Site. RFC Eastleigh was a pre-war civilian airfield requisitioned as an Aircraft Acceptance Park (AAP) for the delivery and testing of newly produced aircraft. It was also used by the United States Naval Air Service (USNAS) as a staging base for operations in Europe. After WWI, the airfield remained in use. It is currently Southampton Airport.

During WWII, the nearest operational airfield was RAF Soberton, approximately 5.6km northeast of the Site. The airfield opened in 1940. It was designated as a Reserve Landing Ground (RLG) for other airfields in the region, in the event that they should become unusable. It was also used as an Emergency Landing Ground (ELG) for aircraft in distress. After WWII, RAF Soberton closed. It has since returned to agricultural use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.3 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.4 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots, or munitions disposal areas on or in close proximity to the Site have been found.

3.5 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

3.6 Other military establishments

The following other military establishments have been identified in the vicinity of the Site.

3.6.1 Marshalling areas

During 1944, troops, equipment, and supplies were concentrated within designated marshalling areas across the southern United Kingdom (UK) in preparation for the 'D-Day' landings in occupied France. The Site was located in the vicinity of Marshalling Area 'A'.

No records have been found to indicate that any establishments or activities associated with the marshalling area encroached on the Site. The nearest feature associated with the marshalling area was a Detail Issue Depot (DID) at Curdridge, approximately 1km southwest of the Site.

Additionally, anecdotal evidence indicates that United States (US) Army forces were accommodated at Shedfield House (SU 553136), approximately 0.8km southwest of the Site. A greasing depot for waterproofing activities was established on Shedfield Common (SU 562130), approximately 0.7km south of the Site.

From September 1944, the marshalling areas were no longer required. Their associated military establishments were subsequently dismantled.

Marshalling areas are not considered to provide a significant source of UXO hazard to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over one-third of the total number of bombs falling in Hampshire fell on Southampton and Portsmouth over 9km from the Site.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial sites in Hampshire. Operational airfields in Hampshire were deliberately targeted by the Luftwaffe including RAF Southampton, approximately 8km west of the Site.

During WWII Southampton, approximately 10km west-southwest of the Site, was an important Luftwaffe target because of its docks, aircraft manufacturing works, and other industries important to the war effort. Bombing densities greatly decreased further inland.

Bombing densities significantly decreased in the surrounding rural districts, with raids mainly carried out by single aircraft dropping small numbers of bombs or jettisoning unused payloads.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including military barracks and camps, and the Southern Railway network.

The nearest identified Luftwaffe target was West End Camp, approximately 5km west-southwest of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Pilotless Aircraft (V1s) and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Portsmouth CB	1,221	34	7	1,262	136.8
Havant & Waterloo UD	375	39	9	423	35.0
Fareham UD	447	11	18	476	25.9
Petersfield RD	457	9	19	485	8.6
Winchester RD	795	19	26	840	7.6
Alton RD	472	2	13	487	7.4

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

18th November 1940

1No. High Explosive (HE) bomb fell on Shirrell Heath, approximately 0.3km east-northeast of the Site.

6th December 1940

1No. Oil Bomb (OB) fell on open ground south of Bishop's Waltham, approximately 0.5km northeast of the Site.

1st March 1941

1No. HE bomb fell on Hedgehog Row, approximately 0.5km southwest of the Site. This was recorded as an UXB.

22nd June 1942

1No. HE bomb fell on a field south of Solomon's Lane, approximately 0.5km east of the Site.

11th July 1944

1No. V1 fell on Woodman's Farm, approximately 10m south-southwest of the Site.

1No. V1 fell on a field off Curdridge Lane, approximately 0.4km south of the Site.

Date Unspecified

1No. HE bomb fell on a field west of Winchester Road, approximately 40m east of the Site.

1No. HE bomb fell on a field southwest of Sandy Hills House approximately 40m southwest of the Site.

1No. HE bomb fell on a field west of Sandy Lane, approximately 0.3km north-northeast of the Site.

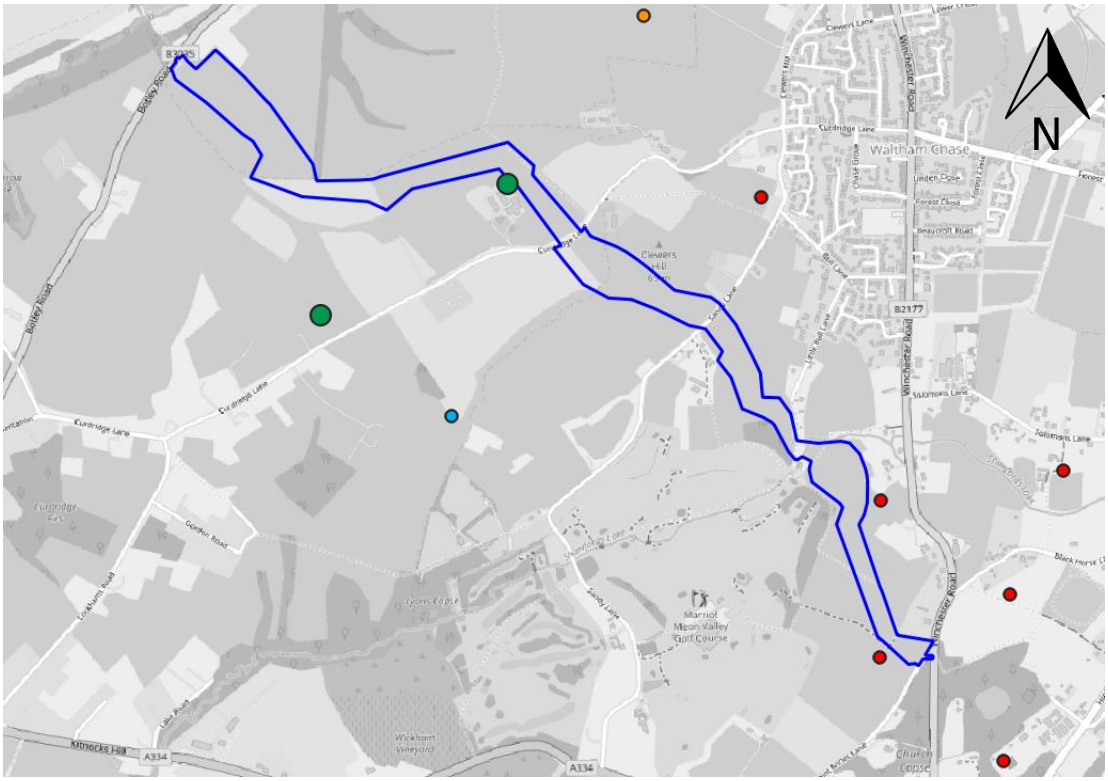
1No. HE bomb fell on New Place Preparatory School, approximately 0.4km southeast of the Site.

Figure 2 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R6-MAP01-A.

Figure 2 Compiled bomb impact map for the vicinity of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB
	OB	V1	

Plate 2 is an aerial photograph of the northern part of the Site, dated the 13th April 1947. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 2 Aerial photograph of the northern part of the Site, 13th April 1947

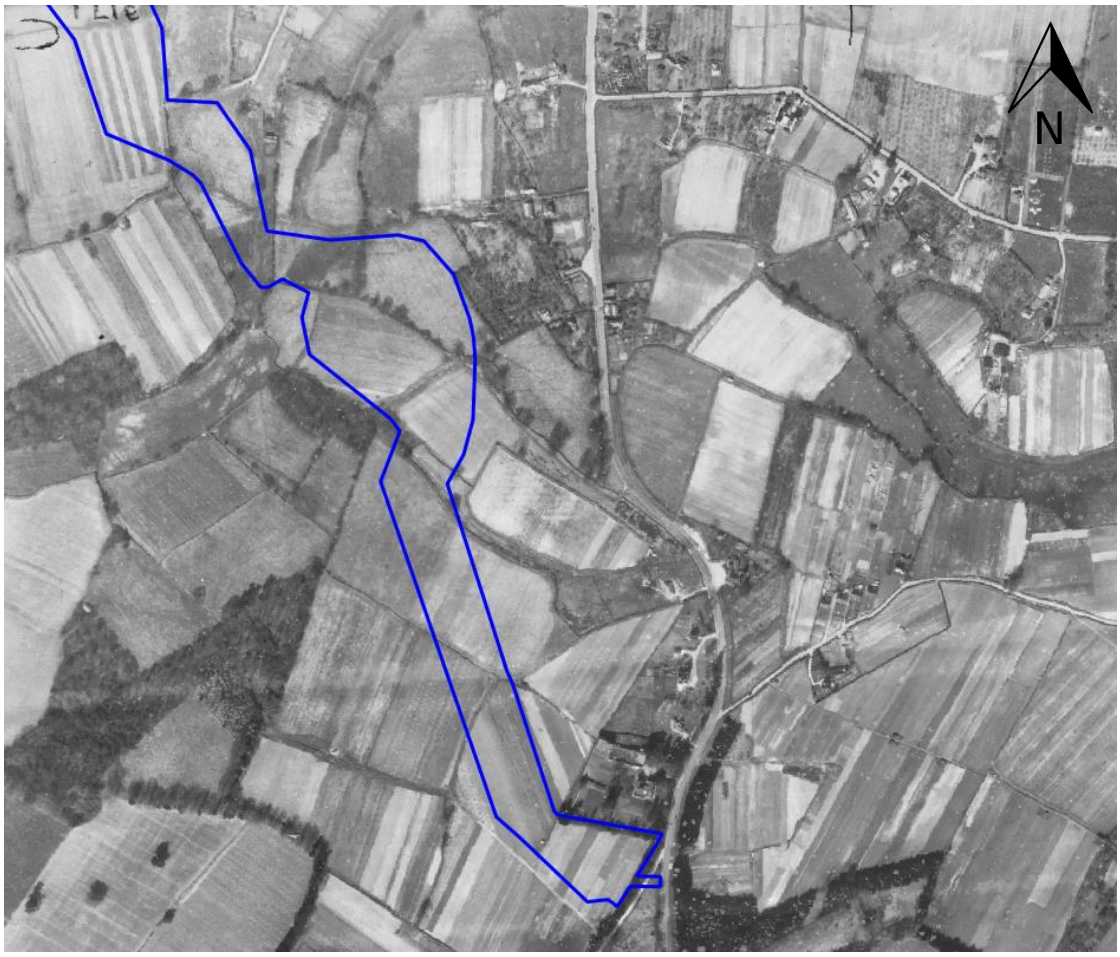


Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 3 is an aerial photograph of the southern part of the Site, dated the 13th April 1947. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 3 Aerial photograph of the southern part of the Site, 13th April 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage or cratering has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of Made Ground and open ground, over clays to gravels, overlying clays and sands of the London Clay and Wittering Formations.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 1m of topsoil (modelled as soft clay), over more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	6.0m
	250kg	8.5m
	500kg	14.0m

Where Made Ground was present, the estimated average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place on and in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 3.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R6-MAP01-A.

Figure 3 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in excavations works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

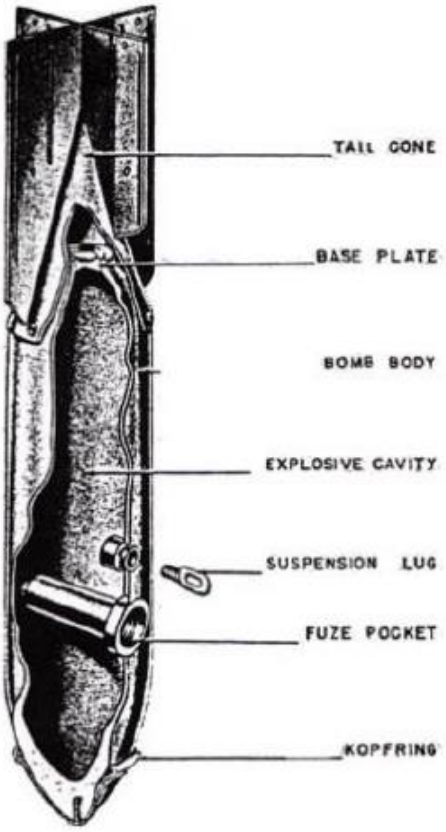
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



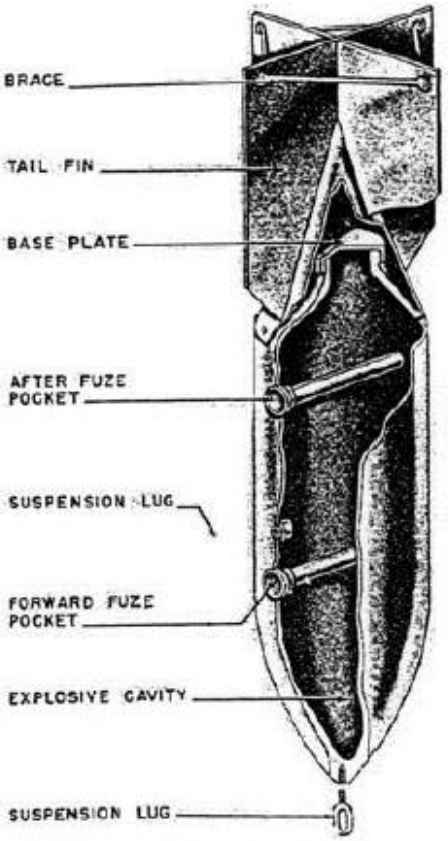




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



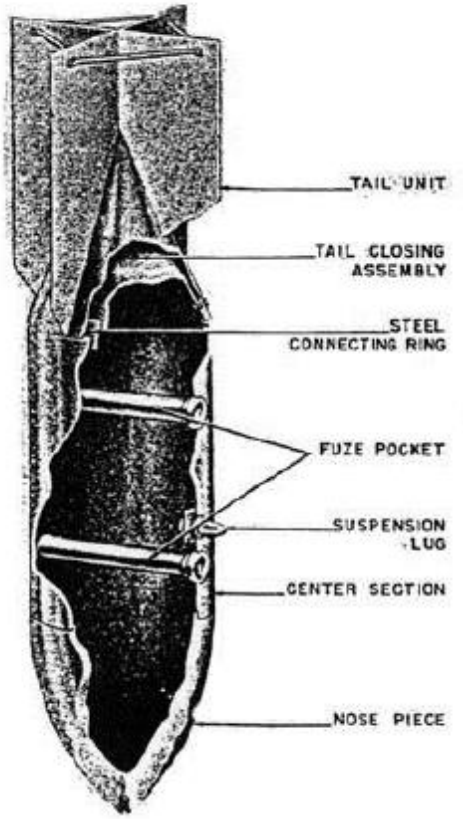




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.

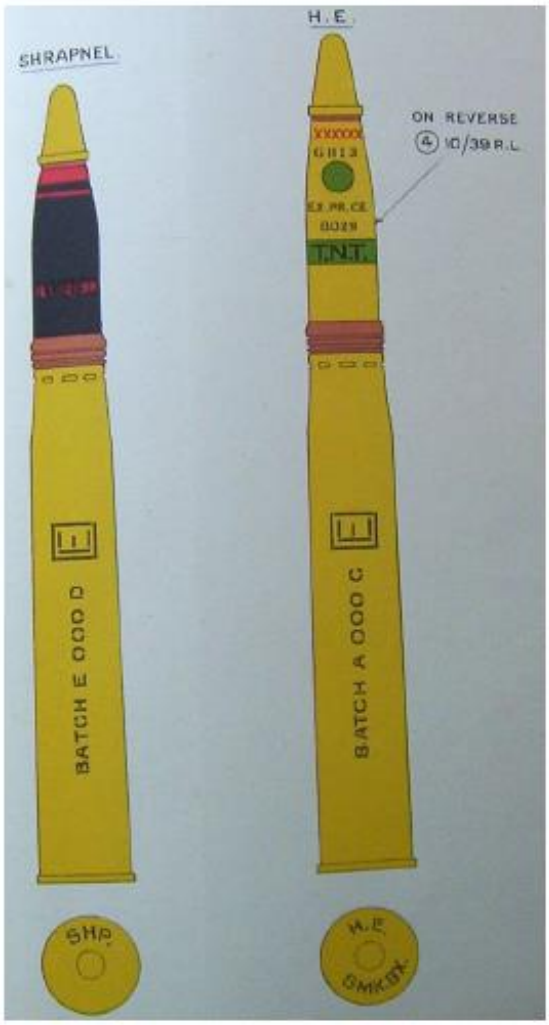






Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell



Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.





Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

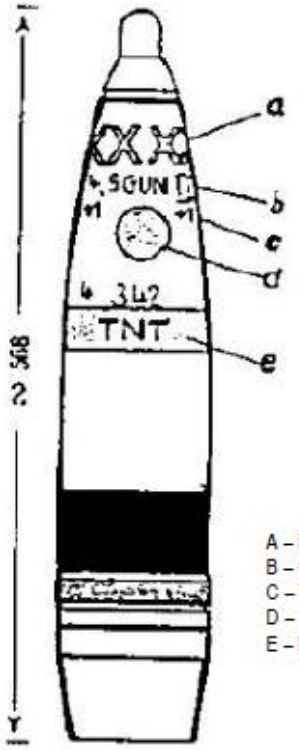
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

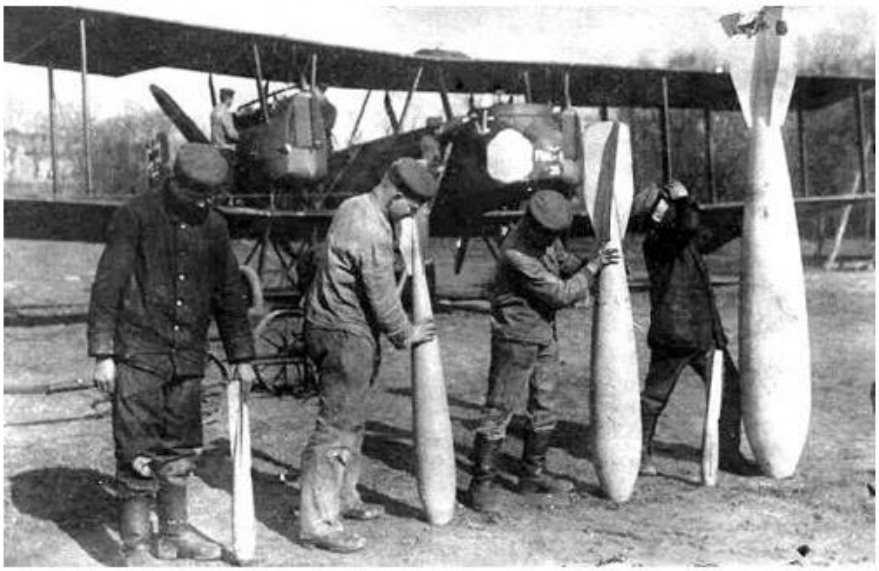
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Leete J, In Time of War: Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War, 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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6. The report has been written utilising relevant guidance and legislation in use at the time of report compilation. Subsequent improvement in techniques, changes in legislation or in site conditions may render parts of this report obsolete. If the report is utilised after such changes have occurred or at a time in excess of 1 year of the issue date, it would be prudent to contact Zetica Ltd to reassess the report under a new contract (see pg. ii).

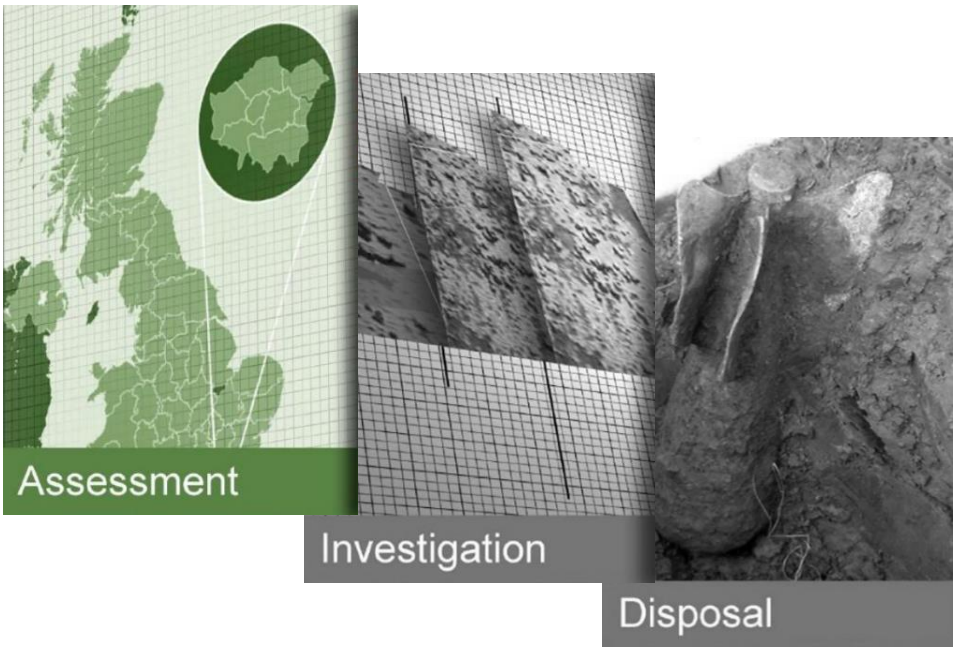
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- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R5**
Revision	**A**
Project Title	**K Site**
Client	**Southern Water**
Date	**26th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

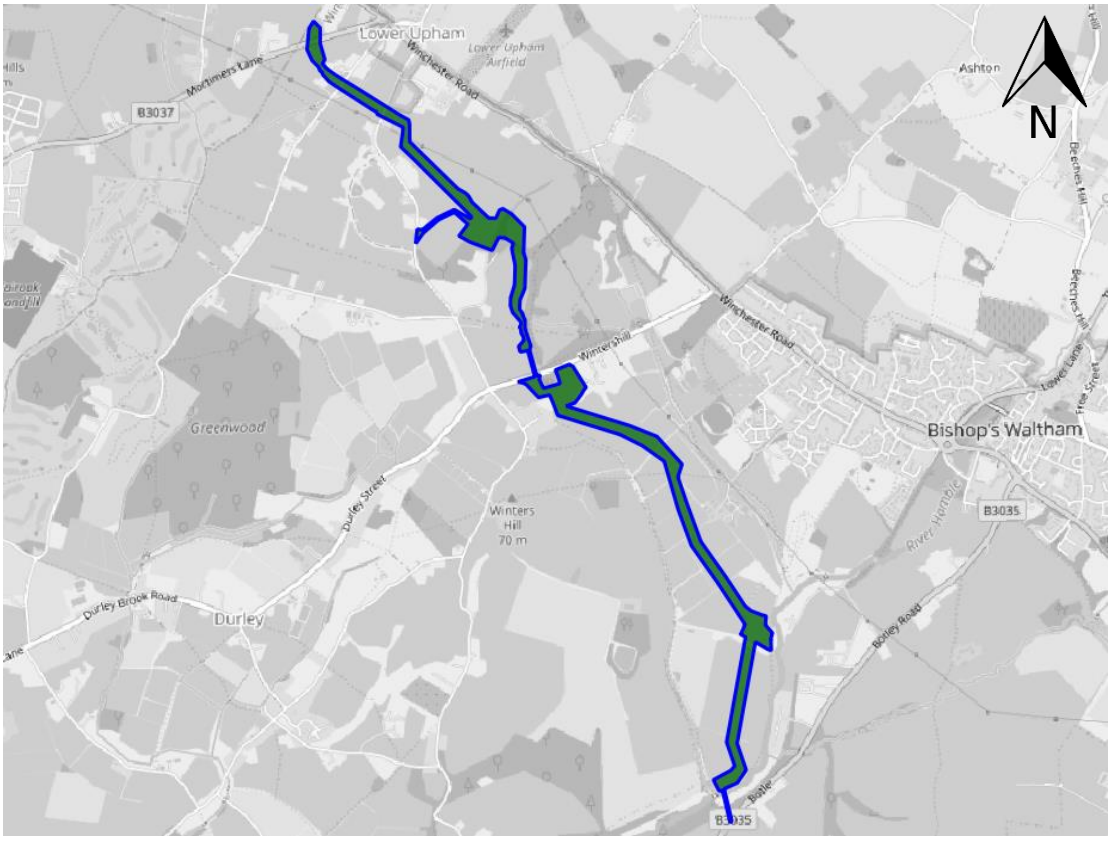
UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 3 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R5-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) or World War Two (WWII) have been found.
- During WWII the main strategic targets in the vicinity of the Site included Marwell Hall Airfield and military barracks and camps.

- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 0.2km north-northwest of the Site, on the 19th January 1941.
- There were 9No. Heavy Anti-Aircraft (HAA) and Rocket AA (ZAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	01993 886682		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R5-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
AAP	Air Acceptance Park
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
ASQL	Assault Quick Lighting
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HE	High Explosive
HER	Historic Environment Record
HQ	Headquarters
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
QL	Quick Lightning
RAF	Royal Air Force
RE	Royal Engineers
RFC	Royal Flying Corps
SAA	Small Arms Ammunition
UK	United Kingdom
US	United States
USNAS	United States Naval Air Service
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Southern Water to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a route approximately 4.9km between Mortimers Lane and Botley Road, in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Archives and Local Studies, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

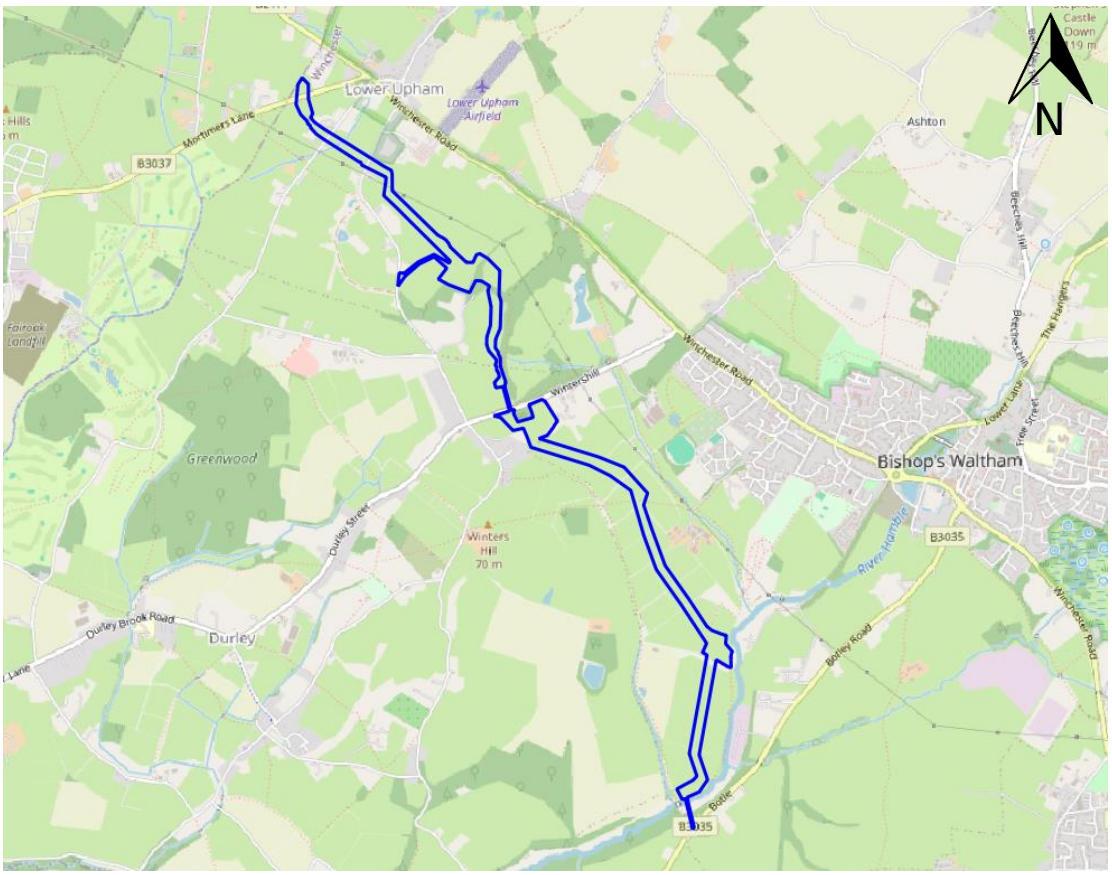
2 THE SITE

2.1 Site location

The Site commences at open ground off Mortimers Lane (SU 519195) and terminates at Botley Road (SU 539156). It comprises roadways and agricultural land. It is bounded to the north by open ground and Winchester Road, to the east and west by roadways and agricultural buildings and land, and to the south by Botley Road.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.1.1 Bombing decoys

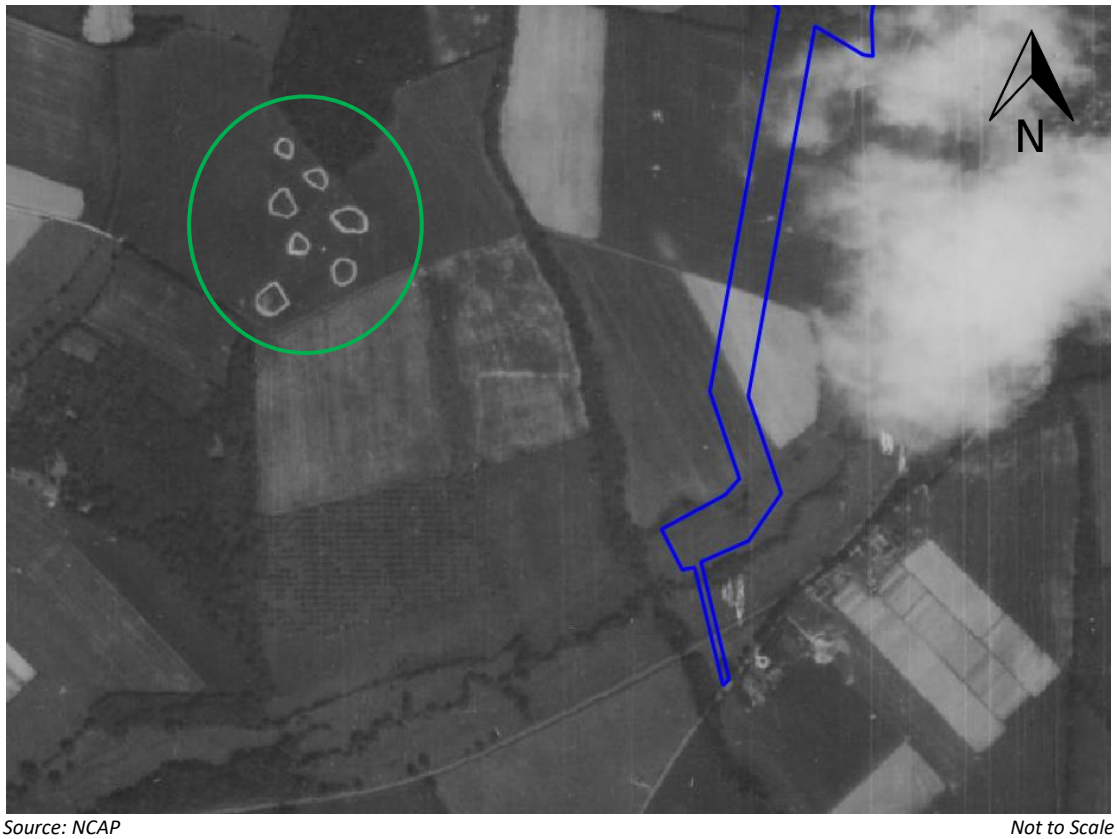
In 1942, a bombing decoy was established at Durley (SU 534162), approximately 0.6km west of the Site. It originally consisted of 2No. decoys.

The first was designed as a Civil Starfish (SF Series) decoy to divert enemy bombing away from Southampton, approximately 12.4km west-southwest of the Site. The Starfish system comprised a series of controlled fires lit during an air raid to replicate an urban area hit by bombs.

The other was used as a Quick Lighting (QL) decoy, part of the 'C-series' of civil decoys, to protect Eastleigh railway junction, approximately 6.7km west of the Site. The QL decoy displayed simulated marshalling yard lights and locomotive glows to reconstruct the railway junction.

Plate 2 is an aerial photograph of the Durley bombing decoy, dated the 29th May 1943.

Plate 2 Aerial photograph of the Durley bombing decoy, 29th May 1943



Source: NCAP *Not to Scale*

Legend	Site boundary	Durley bombing decoy

In August 1943 an Assault QL (ASQL) decoy was overlaid on the previous decoys as part of Operation Starkey. This was a deception program designed to trick the Germans into believing that the Allies were preparing a cross-Channel landing in September 1943. The ASQL displayed lighting to simulate troops assembling near Southampton. The decoy was active between August and September 1943.

The decoy was dismantled after September 1943.

No records have been found indicating that any of the decoys were successful in diverting bombing raids away from Southampton or Eastleigh railway junction and towards the Site. For details of [redacted] in the vicinity of the Site, see Section 4.2.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.1.2 Anti-Aircraft (AA) guns

During WWI there were 2No. AA batteries recorded within 10km of the Site. The nearest was located at Midanbury (SU 446139), approximately 9km southwest of the Site. It was armed with 1No. 18-pounder (-pdr) gun.

During WWII there were 9No. Heavy AA (HAA) and Rocket AA (ZAA) batteries recorded within 10km of the Site. The nearest was located at Bishopstoke (SU 474201), approximately 4.6km west-northwest of the Site. Its armament is unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

10th January 1941

1No. AA shell fell on a field at Brooklands Farm, approximately 0.1km east of the Site.

21st June 1942

1No. AA shell fell on a field at Harfield's Farm, approximately 0.3km east of the Site.

22nd June 1942

1No. AA shell fell on a field at Harfield's Farm, approximately 0.3km south of the Site.

5th April 1943

1No. AA shell fell on a field off Winchester Road, Laurel Farm, approximately 0.9km east of the Site. It was recorded as an Unexploded AA (UXAA) shell.

22nd July 1944

1No. AA shell fell on a field off Winchester Road, approximately 0.8km east of the Site. It was recorded as an UXAA shell.

Potential UXO hazard

Given the number of AA batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.2 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- Military Airfields

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Royal Flying Corps (RFC) Eastleigh, approximately 6.1km west of the Site. RFC Eastleigh was a pre-war civilian airfield requisitioned as an Aircraft Acceptance Park (AAP) for the delivery and testing of newly produced aircraft. It was also used by the United States Naval Air Service (USNAS) as a staging base for operations in Europe. After WWI, the airfield remained in use. It is currently Southampton Airport.

During WWII, the nearest operational airfield was Marwell Hall Airfield, approximately 1.4km northwest of the Site. Marwell Hall Airfield opened in September 1941 as a dispersed storage airfield for aircraft produced and modified at the Cunliffe Owen Aircraft factory, approximately 8km west-southwest of the Site. Marwell Hall Airfield stored modified British and American military aircraft, including Supermarine Seafire and Bell P-39 Airacobra fighter aircraft, and Handley Page Halifax bomber aircraft. By March 1944 Marwell Hall Airfield had closed and returned to civilian use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.3 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- Aircraft Crashes

No records of any aircraft crashes on the Site have been found. The nearest is detailed below.

2nd February 1943

1No. de Havilland Mosquito NF. II (DD665) multi-role aircraft crashed on a field at Bishops Waltham, approximately 1km west of the Site.

Potential UXO hazard

The above crash may have resulted in Small Arms Ammunition (SAA) and cannon shells from aircraft guns being scattered across a wide area, potentially including the Site. SAA is not considered to provide a significant UXO hazard (see Appendix 1).

Aircraft crashes are not considered to provide a significant source of UXO hazard to the Site.

3.4 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots, or munitions disposal areas on or in close proximity to the Site have been found.

3.5 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

3.6 Other military establishments

The following other military establishments have been identified in the vicinity of the Site.

3.6.1 Marshalling Areas

During 1944, troops, equipment, and supplies were concentrated within designated marshalling areas across the southern United Kingdom (UK) in preparation for the 'D-Day' landings in occupied France. The southern part of the Site was located in the vicinity of Marshalling Area 'A'.

No records have been found to indicate that any establishments or activities associated with the marshalling area encroached on the Site.

The nearest feature associated with the marshalling area was the No. 14 Fire Force Headquarters (HQ) at Wintershill Hall (SU 527183) adjacent to the Site. The grounds of the hall encroached on the central part of the Site. From October 1941, Wintershill Hall had been the HQ for the Hampshire Fire Services. No. 14 Fire Force HQ was established at Wintershill Hall in 1944 to co-ordinate and train fire fighters in preparation for overseas service during and after the 'D-Day' landings.

Allied forces were accommodated at camps throughout Marshalling Area 'A'. The nearest camp was located at Fairthorne Manor (SU 522123), approximately 3.3km southeast of the Site, this was occupied by United States (US) Army forces.

From September 1944, the marshalling areas were no longer required. Their associated military establishments were subsequently dismantled.

Marshalling areas are not considered to provide a significant source of UXO hazard to the Site.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over one-third of the total number of bombs falling in Hampshire fell on Southampton and Portsmouth.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial sites in Hampshire. Operational airfields in Hampshire were deliberately targeted by the Luftwaffe including RAF Southampton, approximately 6.1km west of the Site.

During WWII Southampton was an important Luftwaffe target because of its docks, aircraft manufacturing works, and other industries important to the war effort. Bombing densities greatly decreased further inland.

Bombing densities significantly decreased in the surrounding rural districts, with raids mainly carried out by single aircraft dropping small numbers of bombs or jettisoning unused payloads.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including Marwell Hall Airfield (see Section 3.3) and military barracks and camps.

Plate 3 is a Luftwaffe target photograph of Marwell Hall Airfield (outlined thick red), approximately 1.4km northwest of the Site, dated the 3rd November 1943.

Plate 3 Luftwaffe target photograph of Marwell Hall Airfield, 3rd November 1943



Source: NARA *Not to Scale*

Legend	Site boundary

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for Pilotless Aircraft (V1s) and Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Droxford RD	**599**	**38**	**26**	**663**	**10.6**
Southampton CB	2,510	30	12	2,552	277.6
Havant & Waterlooville UD	375	39	9	423	35.0
Eastleigh MB	160	10	3	173	27.6
Winchester RD	795	19	26	840	7.6
Winchester MB	15	0	0	15	3.9

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

6th December 1940

3No. High Explosive (HE) bombs fell on Park Hill Wood, within approximately 0.9km west of the Site.

13th December 1940

1No. HE bomb fell on Stroudwood, approximately 0.6km west of the Site.

19th January 1941

1No. HE bomb fell on Winchester Road, Lower Upham, approximately 0.2km northeast of the Site.

11th February 1941

2No. HE bombs fell on a field off Winchester Road, approximately 0.5km northeast of the Site. These were recorded as UXBs.

4th May 1941

1No. HE bomb fell on Bishops Waltham, approximately 0.9km east of the Site. This was recorded as an UXB.

18th June 1943

2No. HE bombs fell on fields off Scivier's Lane, approximately 0.3km southwest of the Site.

10th November 1943

1No. HE bomb fell on a field at Lodge Farm, approximately 0.3km west-southwest of the Site. This was recorded as an UXB.

14th July 1944

1No. V1 fell on a field at Durley Hall Farm, approximately 0.6km south-southwest of the Site.

Date Unspecified

1No. HE bomb and several IBs fell on fields off Winchester Road, between approximately 0.3km and 0.6km north-northeast of the Site.

5No. HE bombs and several IBs fell on fields off Popes Lane, between approximately 0.5km and 0.7km northeast of the Site.

Figure 2 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R5-MAP01-A.

Figure 2 Compiled bomb impact map for the vicinity of the Site

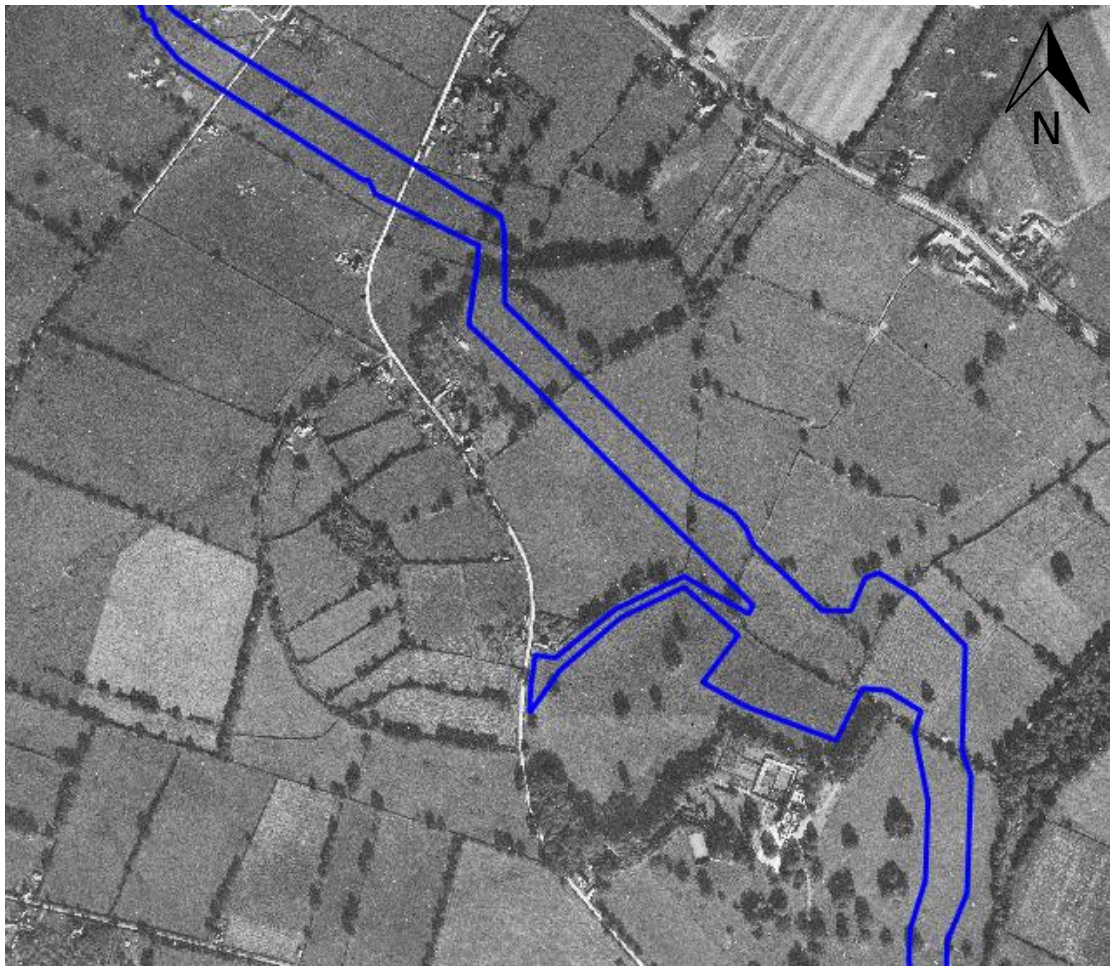


Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB
	V1	IBs	

Plate 4 is an aerial photograph of the northern part of the Site dated the 7th October 1946. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 4 Aerial photograph of the northern part of the Site, 7th October 1946

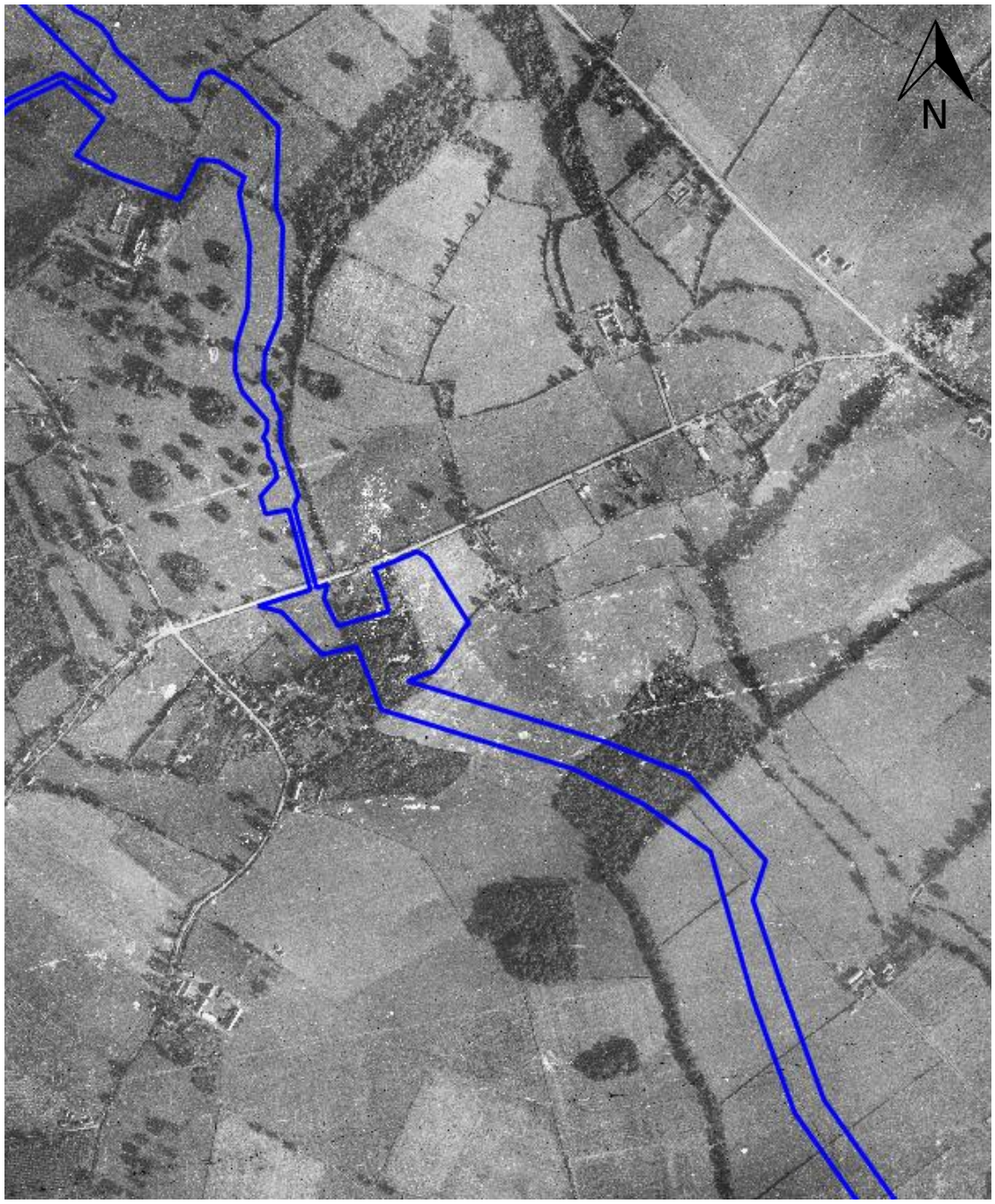


Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 5 is an aerial photograph of the central part of the Site dated the 21st September 1946. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 5 Aerial photograph of the central part of the Site, 21st September 1946

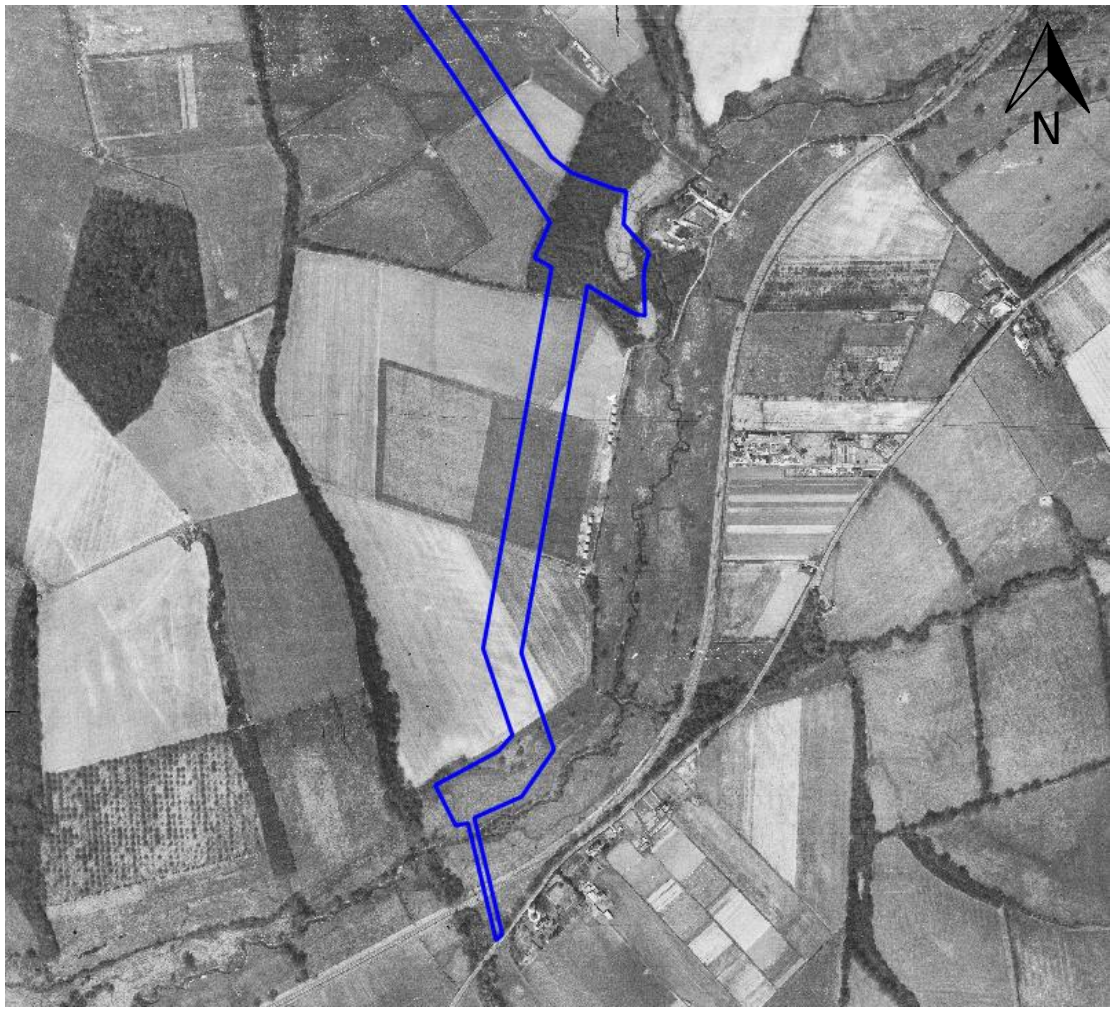


Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 6 is an aerial photograph of the southern part of the Site dated the 13th April 1947. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 6 Aerial photograph of the southern part of the Site, 13th April 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage or cratering has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet 316 Fareham (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of Made Ground and open ground, over river terrace deposits, head, and alluvium, overlying the London Clay Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 0.5m of topsoil (modelled as soft clay), over 2m of clay, silt, sand, and gravel, overlying more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	6.0m
	250kg	8.5m
	500kg	14.0m

Where Made Ground was present, the estimated average bomb penetration depths are likely to be less than the ones given in Table 2.

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ^{o} to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place on and in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

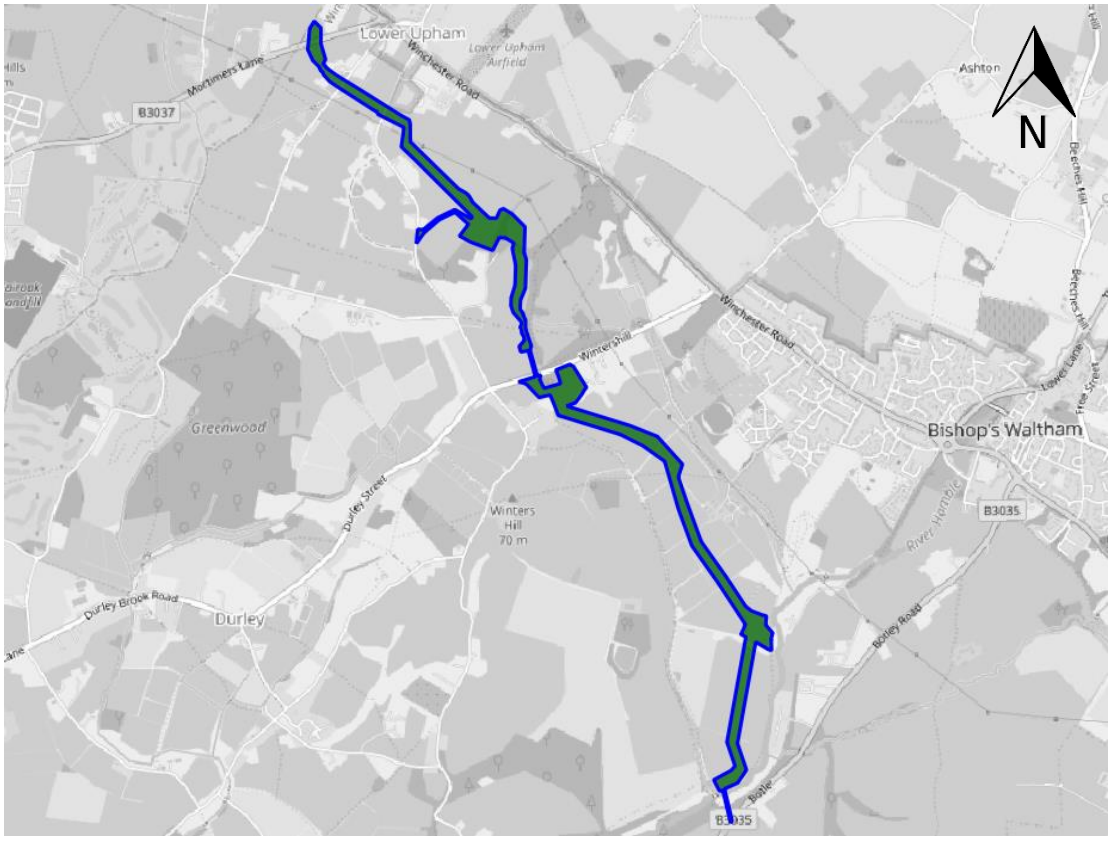
Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 3.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R1-MAP01-A.

Figure 3 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate	
	High		Very High		Site boundary	

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Small Arms Ammunition
Type Various



Description Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal

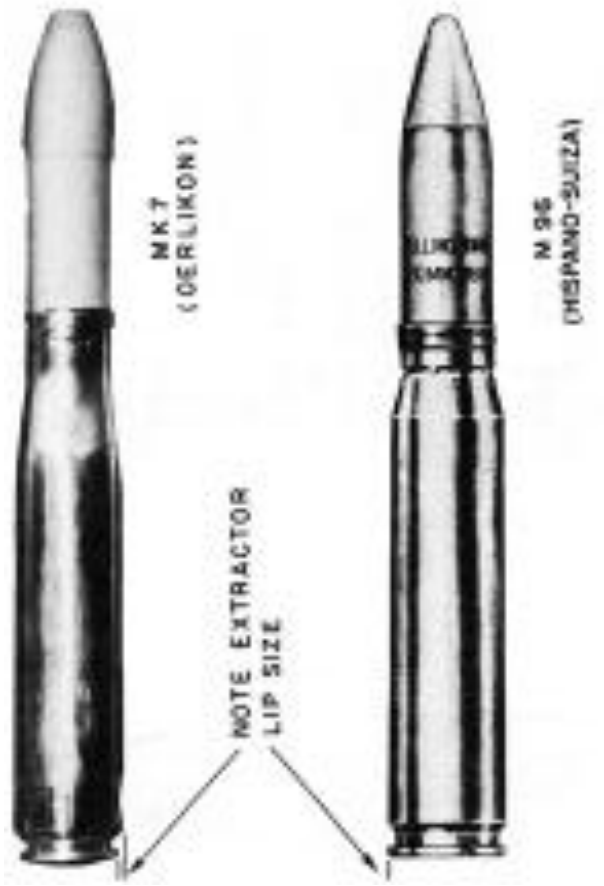




Information Data Sheet

Category Projectiles (British)
Type 20mm Shell

Variants	Numerous
Body Dimensions	20mm x 310mm (0.8" x 7.19")
Weight	0.57lb (0.3lb for projectile)
Fuze	Point-detonating fuze
Composition	Steel casing
Description	Steel casing and projectile with disintegrating belt links at centre and end. Typically a tetryl filling, with some incendiary versions.
Function	Automatic cannon shell for use against ground targets and aircraft.



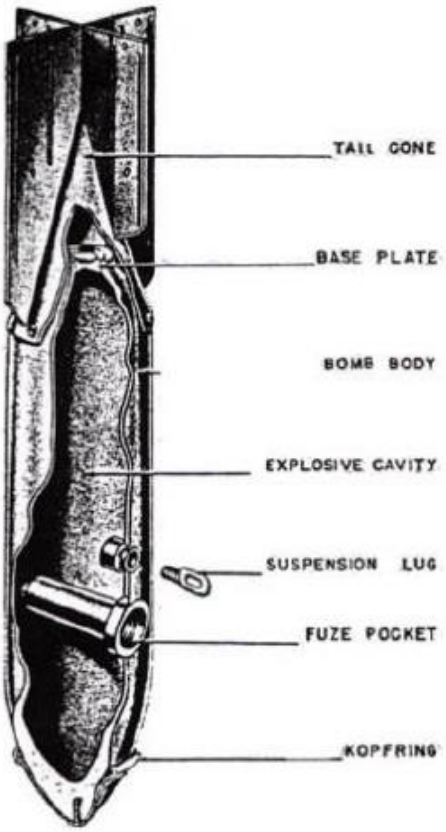




Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



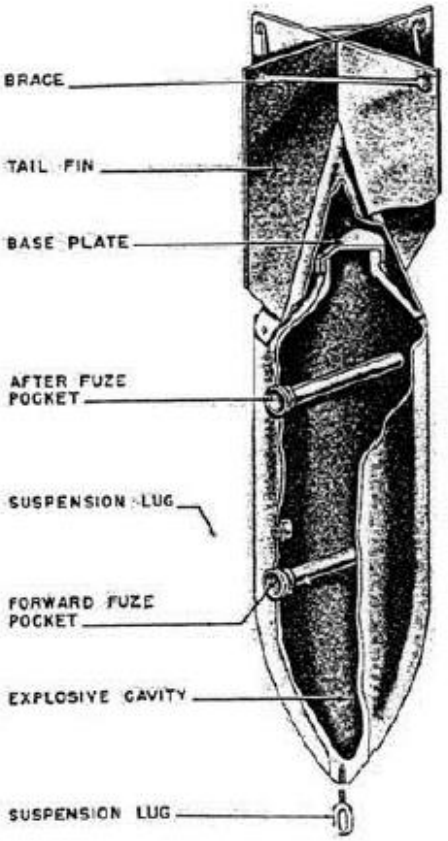




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



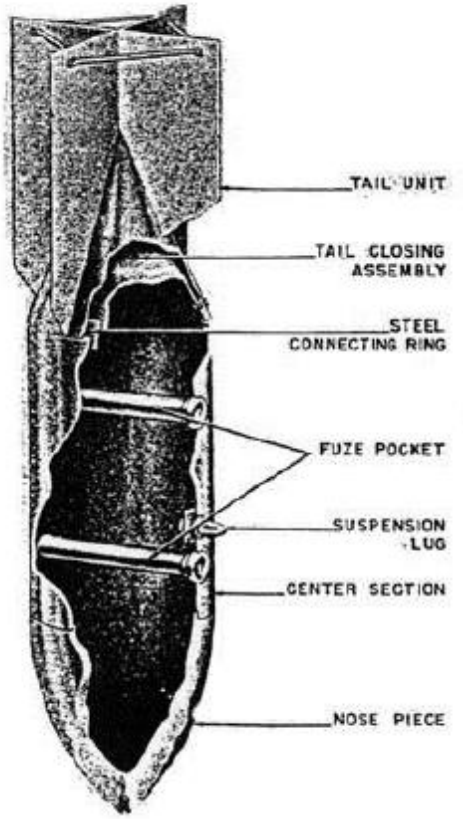




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

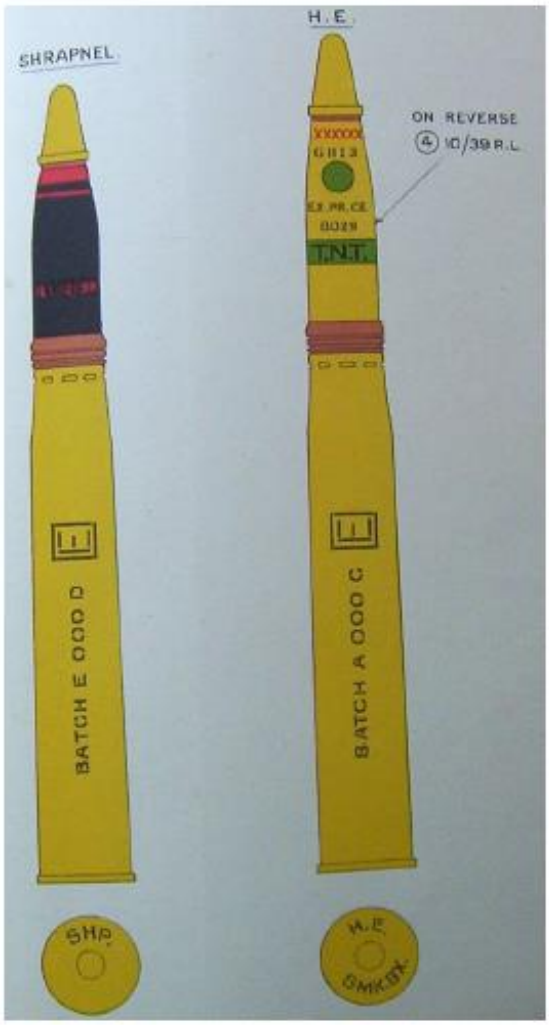
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

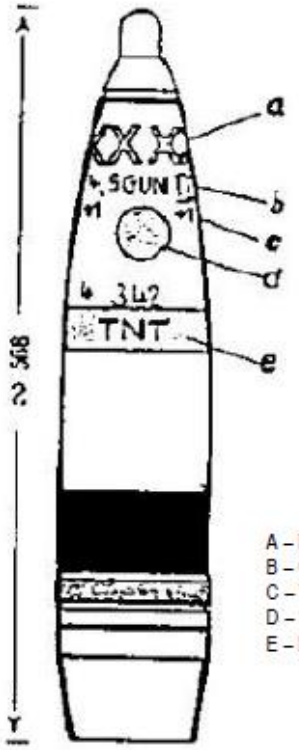
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot
E – Explosives Ring







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

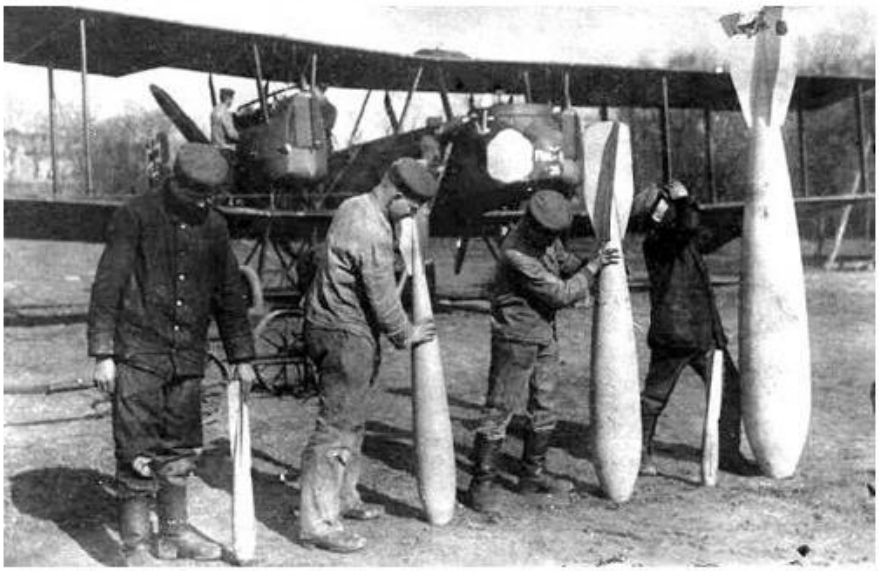
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Leete J, In Time of War: Hampshire, 2007

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War, 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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zeticauxo

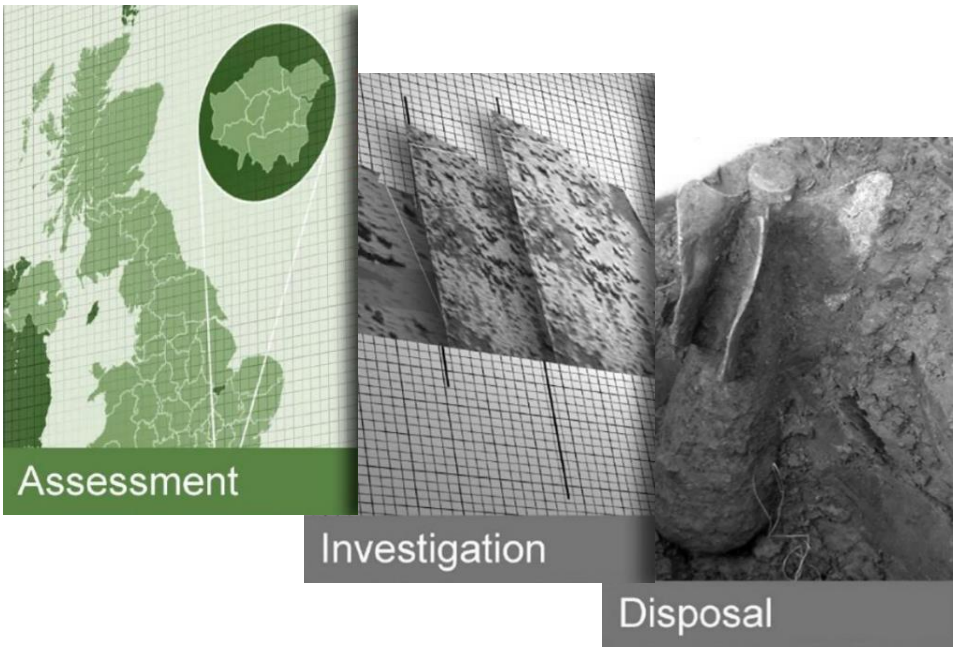
Established for over 32 years, Zetica's services include

- ☑ Desk studies
- ☑ Unexploded ordnance risk assessments and risk mitigation
- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]

zeticaUXO



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R4**
Revision	**A**
Project Title	**L Site**
Client	**Southern Water**
Date	**26th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

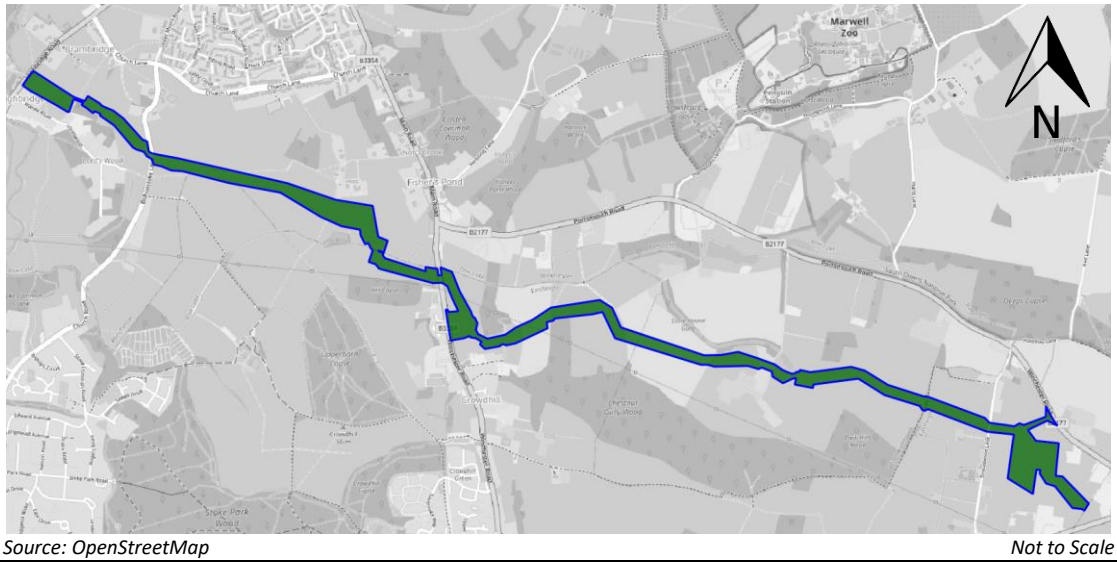
UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R4-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- No records of military activity on the Site during World War One (WWI) or World War Two (WWII) have been found.
- During WWII the main strategic targets in the vicinity of the Site included Marwell Hall Airfield, the Cunliffe Owen Aircraft Works, and military barracks, camps, and training areas.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 30m east-northeast of the Site, on the 22nd June 1942. This was recorded as an Unexploded Bomb (UXB) and later removed.
- There were 7No. Heavy Anti-Aircraft (HAA) batteries within 10km of the Site during WWII. Records indicate that 1No. Anti-Aircraft (AA) shell fell on the Site on 24th December 1940. This was recorded as an Unexploded AA (UXAA) shell and later removed. The potential for a further UXAA shell to have fallen on the Site unnoticed cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.


01993 886682

[redacted]

[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R4-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
AAP	Aircraft Acceptance Park
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HDD	Horizontal Directional Drilling
HE	High Explosive
HER	Historic Environment Record
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
RAF	Royal Air Force
RFC	Royal Flying Corps
RE	Royal Engineers
UP	Unrotated Projectile
US	United States
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
UXPM	Unexploded Parachute Mine
UXUP	Unexploded Unrotated Projectile
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec, on behalf of Southern Water, to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a pipeline route totalling approximately 5.8km between Highbridge and Lower Upham in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Hampshire County Council, Hampshire Record Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

2.1 Site location

The Site commences at Highbridge, at Ordnance Survey National Grid Reference (OSNGR) SU 446882 and terminates at Lower Upham OSNGR SU 519195. It is located approximately 7.9km south-southeast of central Winchester.

The Site comprises open ground, woodland, and roadway. It is bounded on all sides by a mixture of open ground, woodland, roadway, and residential properties.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.1.1 Anti-Aircraft (AA) guns

During WWI there was 1No. AA battery recorded within 10km of the Site. It was located at Midanbury (SU 444686), approximately 7.8km south-southwest of the Site. It was armed with 1No. 18-pdr gun.

During WWII there were 7No. Heavy AA (HAA) batteries recorded within 10km of the Site. The nearest was located at Bishopstoke (SU 474201), approximately 0.9km south of the Site. Its armament is unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

24th December 1940

1No. AA shell fell on a field off Winchester Road, on the central part of the Site. It was recorded as an Unexploded AA (UXAA) shell and later removed.

29th June 1942

1No. Unrotated Projectile (UP) rocket fell on a hay field off Portsmouth Road, approximately 0.3km north of the Site. It was recorded as an Unexploded UP (UXUP) and later removed.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.1.2 Bombing decoys

The nearest recorded bombing decoy was located at Durley (SU 534162), approximately 3.5km southeast of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.2 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Eastleigh Aerodrome, approximately 3.9km south-southwest of the Site. Eastleigh Aerodrome was established in 1917 as an Aircraft Acceptance Park (AAP) for use by the Royal Flying Corps (RFC).

In July 1918 Eastleigh Aerodrome became a United States (US) Navy Air Station and was developed as a base for future bombing operations.

By April 1919 Eastleigh Aerodrome had transferred to civilian and commercial use, and later became Southampton Municipal Airport.

During WWII, the nearest operational airfield was Marwell Hall Airfield, approximately 0.5km north of the Site (see Plate 2). Marwell Hall Airfield opened in September 1941 as a dispersed storage airfield for aircraft produced and modified at the Cunliffe Owen Aircraft factory, approximately 4km south-southeast of the Site.

Marwell Hall Airfield stored modified British and US military aircraft, including Supermarine Seafire fighter aircraft, Bell P39 Airacobra fighter aircraft, and Handley Page Halifax heavy bomber aircraft.

By March 1944 Marwell Hall Airfield had closed and returned to civilian use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.3 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on the Site have been found. The nearest is detailed below.

30th May 1940

1No. Miles Master Mk I (N7706) trainer aircraft crashed on ground near Fisher's Pond off Portsmouth Road, approximately 0.3km north of the central part of the Site.

Aircraft crashes are not considered to provide a source of UXO hazard to the Site.

3.4 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.5 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over one-third of the total number of bombs falling in Hampshire fell on Southampton and Portsmouth over 10km south of the Site.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial sites in Hampshire. Operational airfields in Hampshire were deliberately targeted by the Luftwaffe including RAF Southampton, approximately 3.9km south-southwest of the Site.

During WWII Southampton, approximately 10km south of the Site, was an important Luftwaffe target because of its docks, aircraft manufacturing works, and other industries important to the war effort. Bombing densities greatly decreased further inland.

Bombing densities significantly decreased in the surrounding rural districts, with raids mainly carried out by single aircraft dropping small numbers of bombs or jettisoning unused payloads.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

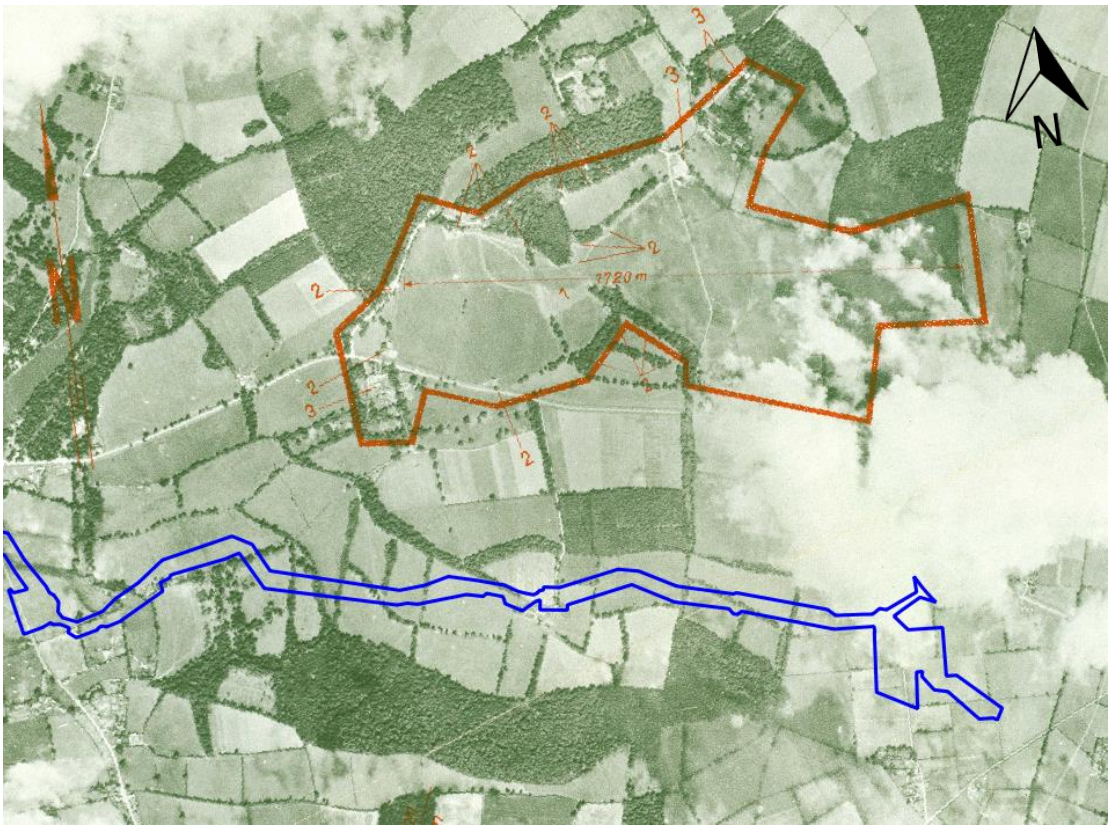
4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including Marwell Hall Airfield (see Section 3.2), the Cunliffe Owen Aircraft Works, and military barracks, camps, and training areas.

Plate 2 is a Luftwaffe target photograph of Upham dated the 3rd November 1943. This shows Marwell Hall Airfield (outlined in red), approximately 0.5km north of the Site.

Plate 2 Luftwaffe target photograph of Marwell Hall Airfield, 3rd November 1943



Source: NARA *Not to Scale*

Legend	Site boundary

4.2.3 Bombing densities and incidents

Error! Reference source not found. gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that **Error! Reference source not found.** excludes the figures for Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Winchester RD	**795**	**19**	**26**	**840**	**7.6**
Southampton CB	2,510	30	12	2,552	277.6
Droxford RD	599	38	26	663	10.6
Romsey & Stockbridge RD	679	74	26	779	9.3
Winchester MB	15	0	0	15	3.9

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

11th September 1940

1No. High Explosive (HE) bomb fell on a field near Marwell Manor Farm, approximately 0.1km north-northeast of the Site.

1No. HE bomb fell on a field near Marwell Manor Farm, approximately 0.3km north-northeast of the Site.

17th November 1940

1No. HE bomb fell on fields opposite the Dog & Crook public house, approximately 0.3km north-northeast of the Site.

22nd November 1940

1No. HE bomb fell on open ground at Crowdhill, approximately 0.2km west of the Site. This was recorded as an UXB and later removed.

24th November 1940

3No. HE bombs and 13No. IBs fell on ground between Brambridge Road, approximately 0.2km north of the Site, and Main Road, approximately 0.2km north-northeast of the Site.

6th December 1940

3No. HE bombs fell on the east end of Park Hill Wood, approximately 0.3km south-southwest of the Site.

13th December 1940

1No. HE bomb fell on Stroudwood, approximately 0.3km southwest of the Site.

14th March 1941

1No. HE bomb fell on the grounds of Marwell Hall, approximately 0.5km north-northeast of the Site.

22nd June 1941

1No. Parachute Mine (PM) fell on open ground off Portsmouth Road, approximately 0.3km north of the Site. This was recorded as an Unexploded (UXPM) and later removed.

22nd June 1942

3No. HE bombs fell on a field near Crowd Hill, approximately between 30m east-northeast and 0.1km north-northeast of the Site. These were recorded as UXBs and later removed.

27th June 1942

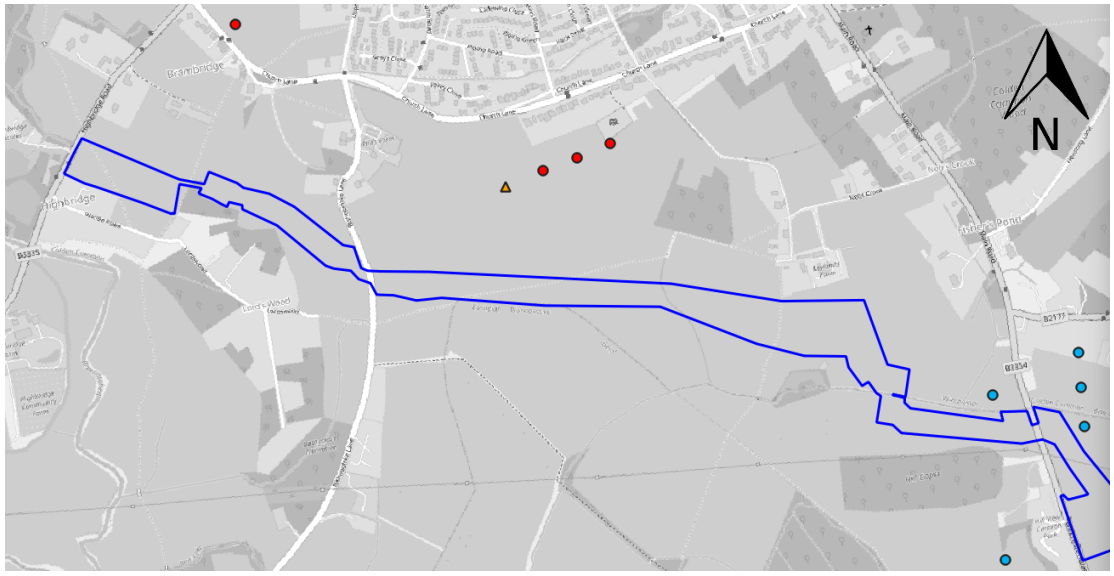
1No. 500kg HE bomb fell on a field near the Queen's Hotel, approximately 40m north-northwest of the Site. This was recorded as a UXB and later removed.

Figures 2 and 3 are maps showing the approximate locations of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R4-MAP01-A.

Figure 2 Compiled bomb impact map for the vicinity of the western part of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB	IBs

Figure 3 Compiled bomb impact map for the vicinity of the eastern part of the Site

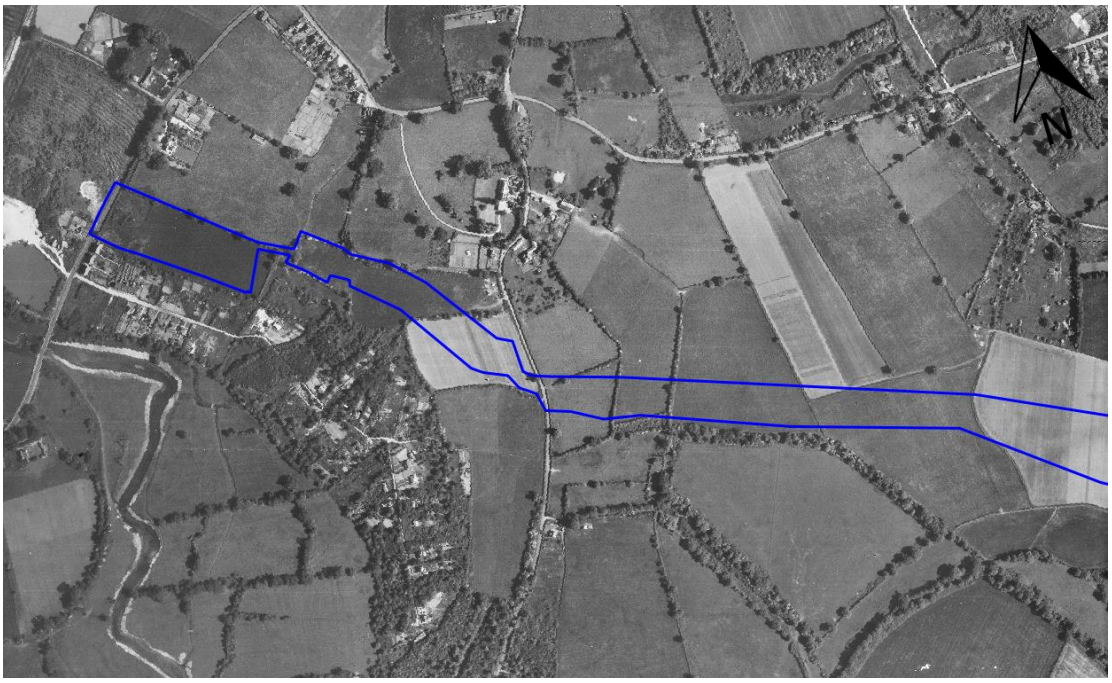


Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXPM

Plate 3 is an aerial photograph of the western part of the Site dated the 28th May 1947. No bomb damage or cratering has been identified on or in the vicinity of this part of the Site.

Plate 3 Aerial photograph of the western part of the Site, 28th May 1947



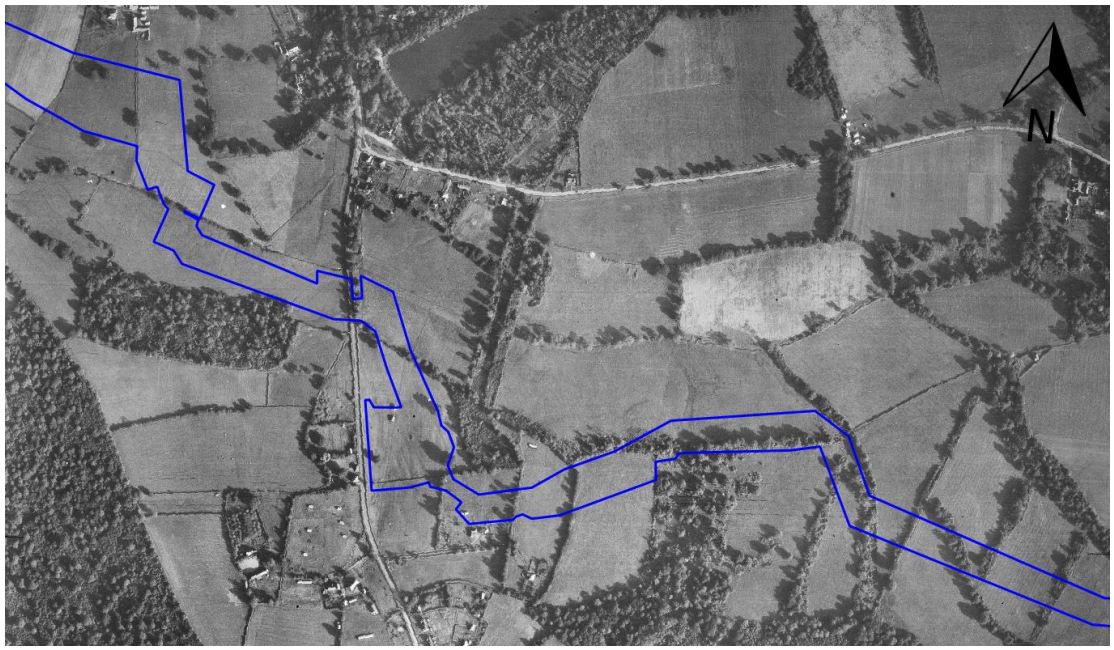
Source: Historic England *Not to Scale*

Legend	Site boundary

Plates 4 and 5 are aerial photographs of the central and eastern parts of the Site dated the 21st September 1946. No bomb damage or cratering has been identified on these parts of the Site.

Some cratering has been identified to the south of the eastern part of the Site.

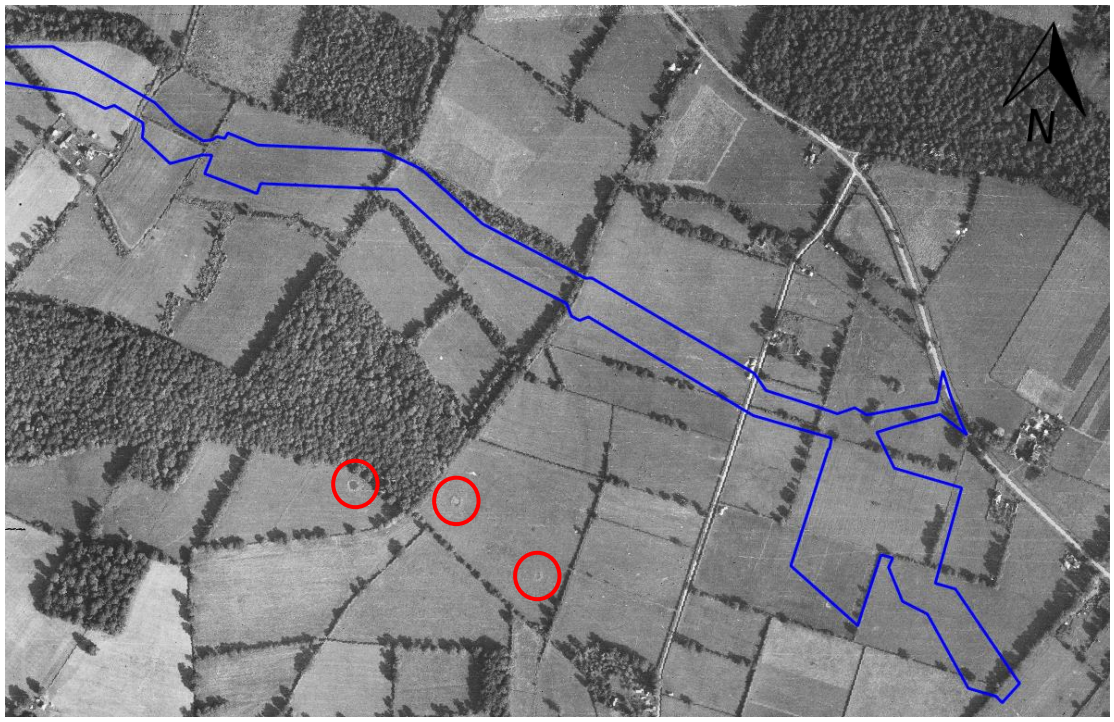
Plate 4 Aerial photograph of the central part of the Site, 21st September 1941



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 5 Aerial photograph of the eastern part of the Site, 21st September 1941



Source: Historic England *Not to Scale*

Legend	Site boundary	Possible cratering

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage or cratering has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

BGS 1:50,000 Sheet 315 Southampton (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground, over alluvium deposits of clay, silt, sand, and gravel, over the London Clay Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 4m of soft clay, over more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	6.5m
	250kg	9.0m
	500kg	14.5m

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

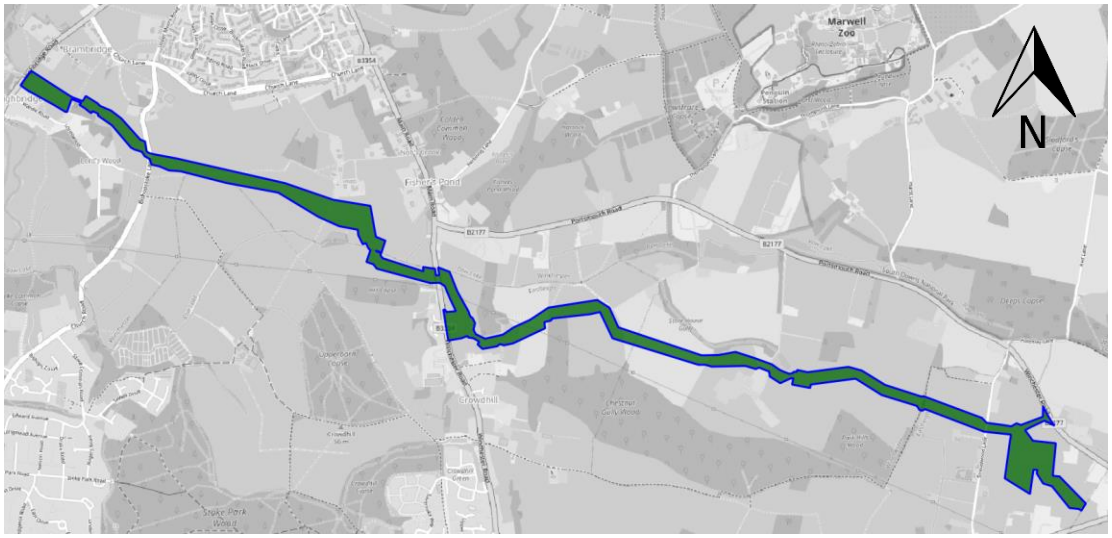
Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R4-MAP01-A.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

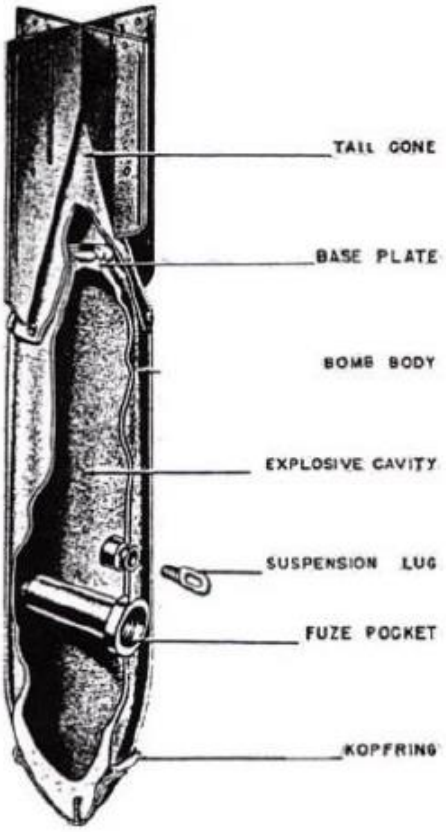
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



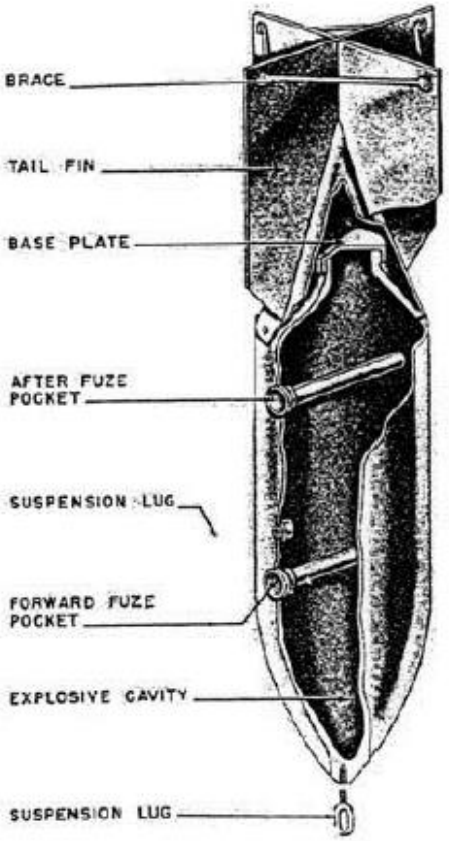




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



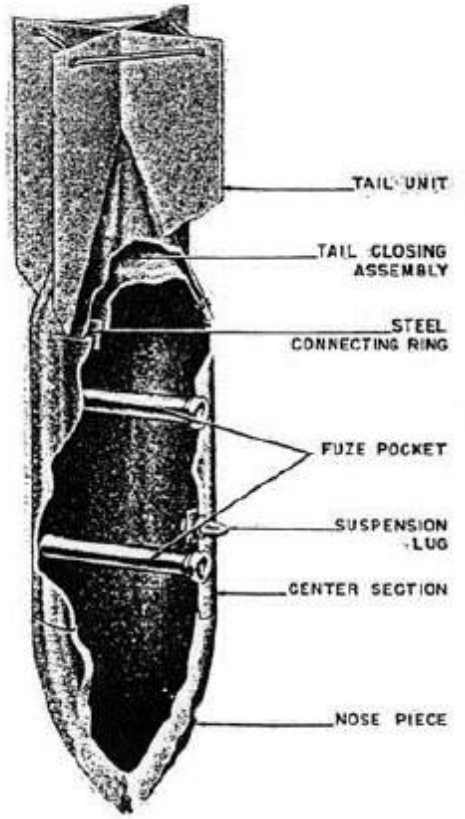




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

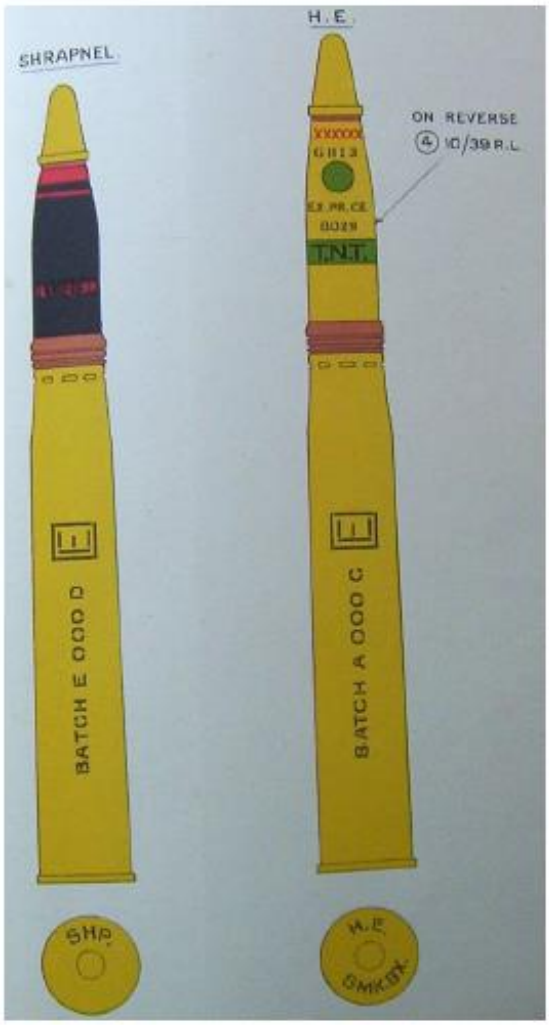
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.







Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants -

Body Dimensions 114mm x 566mm (4.5" x 21.9")

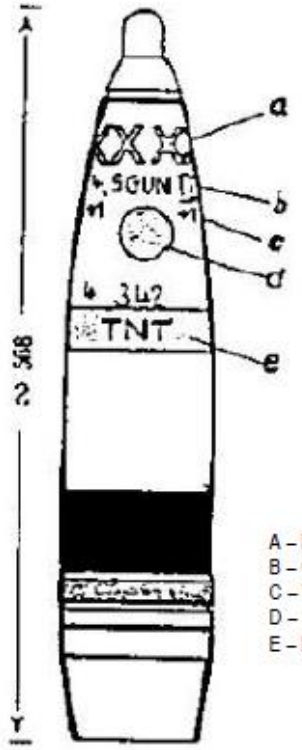
Weight 24.9kg (55lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.

Function Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.









Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

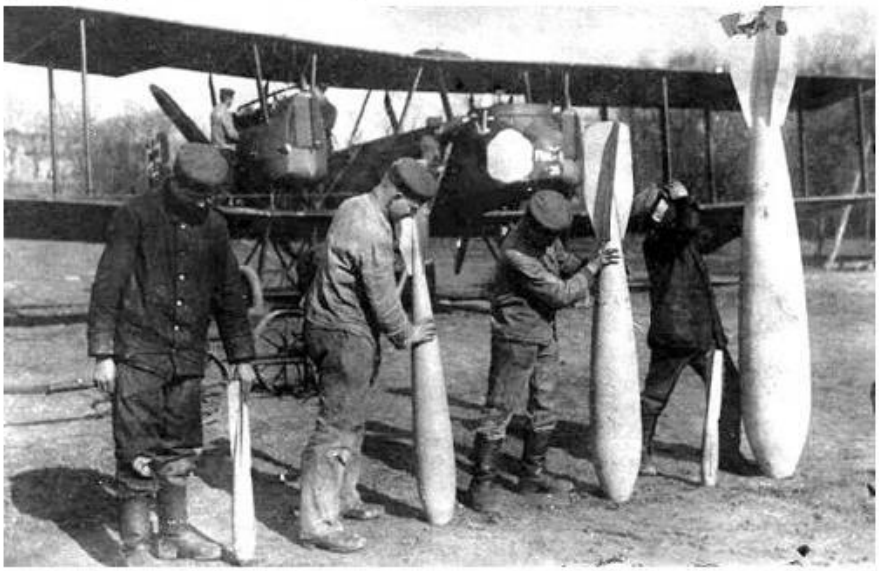
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

Brookes R J, Airfields in the Second World War, Hampshire, 1996

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

Appendix 6 General Notes

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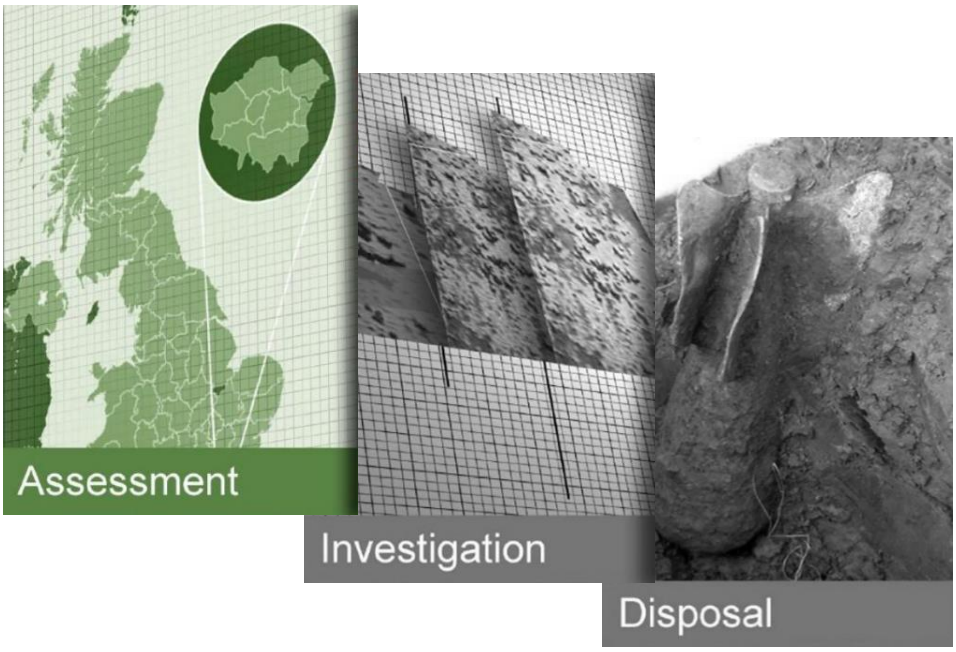
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- ☑ Desk studies
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- ☑ Utility services detection
- ☑ Environmental and engineering geophysical surveys
- ☑ Transport infrastructure surveys
- ☑ Pipeline & cable route surveys
- ☑ Intrusive ground investigations

More details are available at

[redacted]



UXO Desk Study & Risk Assessment

Document Ref.	**P14032-24-R3**
Revision	**A**
Project Title	**M Site**
Client	**Southern Water**
Date	**18th March 2024**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

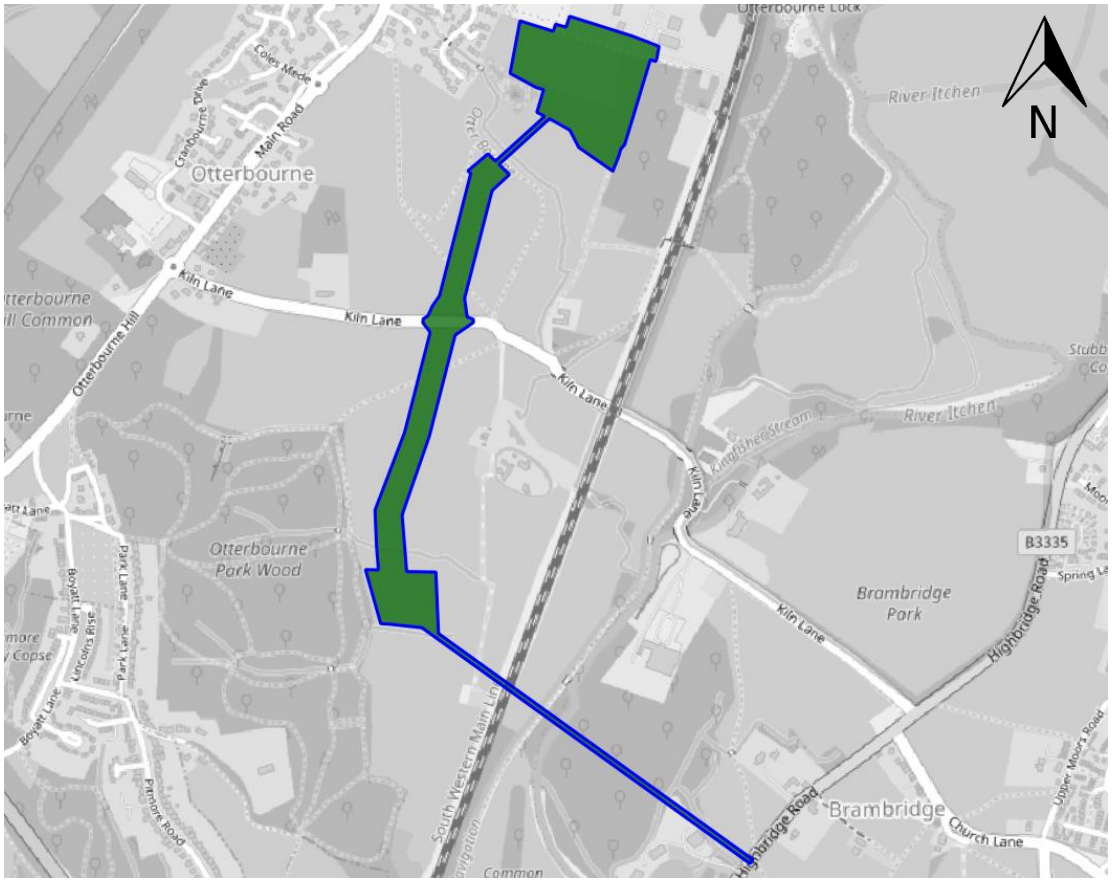
UXO hazard assessment

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 4 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R3-MAP01-A.

UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- In 1944, the Site was located within D-Day Marshalling Area 'C'. This involved the build up of troops and materials in preparation for D-Day.

- During World War Two (WWII) the main strategic targets in the vicinity of the Site included Marwell Hall Airfield, aircraft manufacturing, and military barracks, camps, and training areas.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell adjacent to the western boundary of the Site, on the 18th November 1940. This was recorded as an Unexploded Bomb (UXB) and removed.
- There were 8No. Heavy Anti-Aircraft (HAA) batteries within 10km of the Site during WWII. The potential for an Unexploded AA (UXAA) shell to have fallen on the Site cannot be discounted.

Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

Risk assessment

The Table below, reproduced as Table 3 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

Risk mitigation plan

The Table below, reproduced as Table 4 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

What do I do next?

If you have any comments or require further assistance, contact us and we can help.

	**01993 886682**		[redacted]		[redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

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P14032-24-R3-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
AAP	Aircraft Acceptance Park
ALARP	As Low As Reasonably Practicable
AP	Anti-Personnel
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BGS	British Geological Survey
CIRIA	Construction Industry Research and Information Association
CRE	Canadian Royal Engineers
CW	Chemical Warfare
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
HAA	Heavy Anti-Aircraft
HE	High Explosive
HER	Historic Environment Record
IB	Incendiary Bomb
IWM	Imperial War Museum
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
NARA	National Archives & Records Administration
NCAP	National Collection of Aerial Photography
OB	Oil Bomb
OSNGR	Ordnance Survey National Grid Reference
PM	Parachute Mine
QM	Quarter Master
RAF	Royal Air Force
RFC	Royal Air Force
RE	Royal Engineers
SWML	South West Main Line
US	United States
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WO	War Office
WWI	World War One
WWII	World War Two
ZAA	Rocket Anti-Aircraft

UXO DESK STUDY & RISK ASSESSMENT

Please read: Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at [redacted] If you cannot gain access to these resources, Zetica can forward them on request.

1 INTRODUCTION

1.1 Project outline

Zetica Ltd was commissioned by Stantec, on behalf of Southern Water, to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for a pipeline route totalling approximately 2.2km between Otterbourne and Highbridge in Hampshire (the 'Site').

The aim of this report is to gain a fair and representative view of the potential UXO hazard on or affecting the Site in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Where appropriate, this hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance.
- Probable location.
- Ordnance condition.

It should be noted that some military activity providing a source of UXO hazard may not be recorded and therefore there cannot be any guarantee that all UXO hazards affecting the Site have been identified in this report.

1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two ([redacted] and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps [redacted] previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

1.2.2 Historical records, maps, and drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, and relevant archaeological bodies.

The British Geological Survey (BGS) was consulted for borehole information.

1.2.3 Local records

Otterbourne Parish Council, Hampshire Record Office, local historical groups, and the Hampshire Historic Environment Record (HER) were consulted for records.

1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

Definitions of data confidence level		
Data Confidence Level		**Definition**
	Low	There are very few sources of information, and/or those available are lacking in detail.
	Moderate	There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.
✓	**High**	There is a wide range of available sources of information, which are detailed and corroborate each other.

2 THE SITE

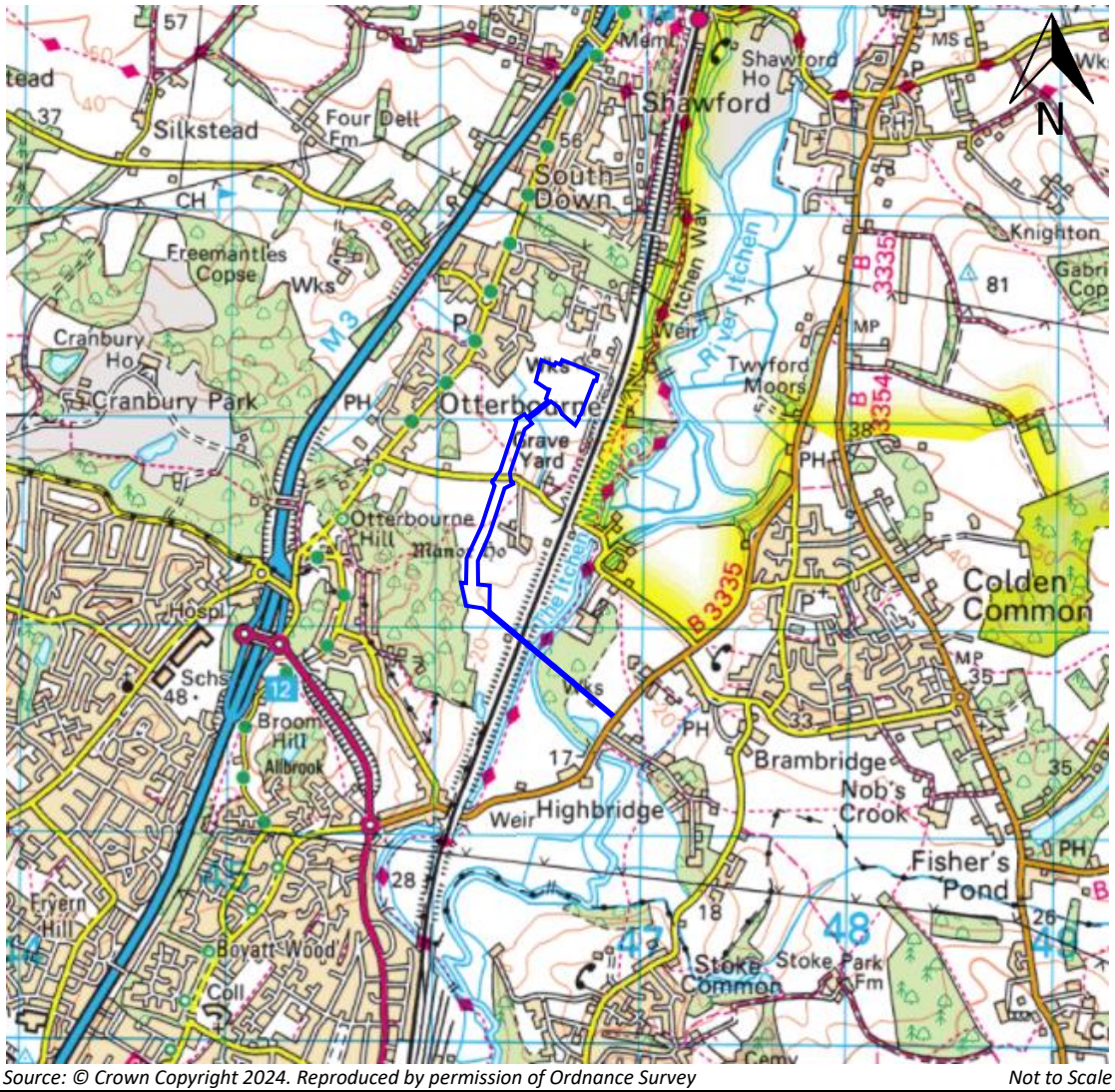
2.1 Site location

The Site commences at Otterbourne, at Ordnance Survey National Grid Reference (OSNGR) SU 456232 and terminates at Highbridge OSNGR SU 469216. It is located approximately 5.8km south of central Winchester.

The Site comprises open ground, woodland, roadway, and part of the South West Main Line (SWML) railway. It is bounded to the north by Oakwood Park Recreational Ground and industrial buildings, to the east and south by open ground, woodland, and the SWML railway, and to the west by open ground and woodland.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



Source: © Crown Copyright 2024. Reproduced by permission of Ordnance Survey *Not to Scale*

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site



Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

The following sections outline the recorded military activity in the vicinity of the Site. The potential UXO hazard from WWI and [redacted] is detailed in Section 4.

3.1 Marshalling Area 'C'

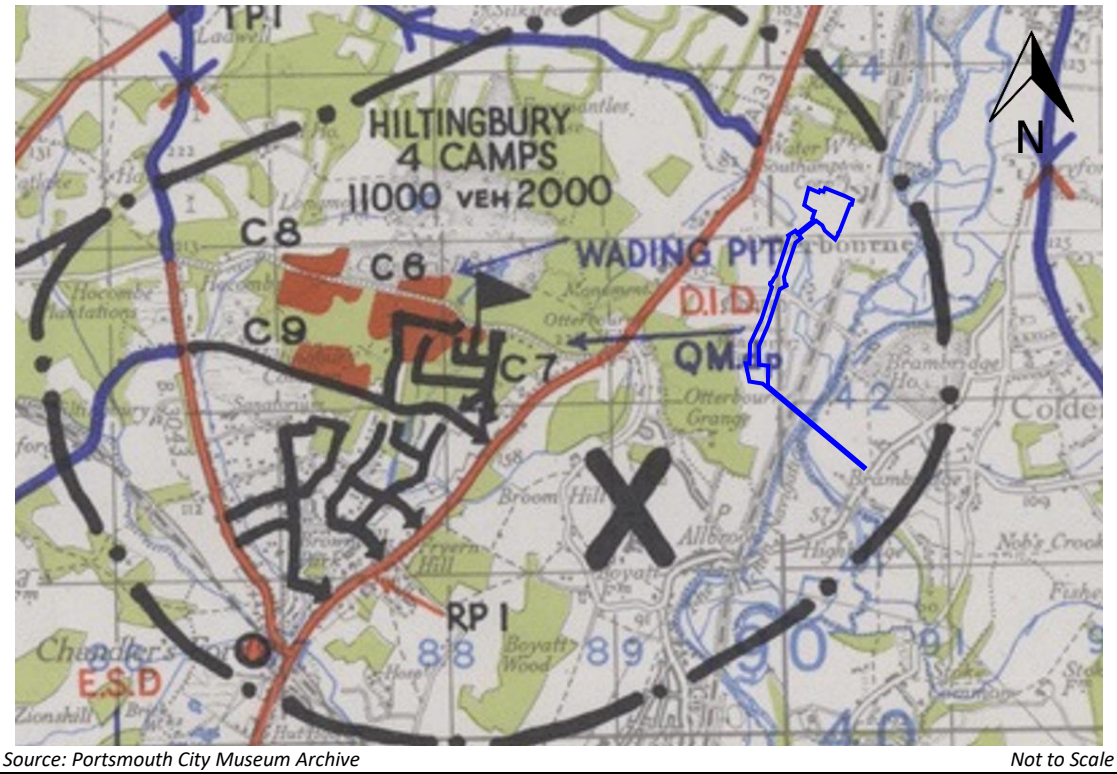
In 1944, during preparations for the D-Day invasions of Normandy, a series of Marshalling Areas were established throughout southern England. They comprised several camps and were used to assemble troops, vehicles, munitions, and equipment.

The Site was encompassed by sub-area 'X' of Marshalling Area 'C'. This accommodated 11,000No. Canadian and United States (US) troops and 2,000No. vehicles, from units including the 1517th Quarter Master (QM) truck battalion, 85th Chemical Warfare (CW) Company, and 18th Field Company Canadian Royal Engineers (CRE).

No records of camps on or in the vicinity of the Site have been found. The nearest camp was 'C7' located at Hiltingbury, approximately 1.5km west of the Site.

Figure 2 is an extract from a plan of Marshalling Area 'C', dated the 1st May 1944. This shows sub-area 'X' and camps 'C6' – 'C9'.

Figure 2 Plan of Marshalling Area 'C', 1st May 1944



Source: Portsmouth City Museum Archive *Not to Scale*

Legend	Site boundary	Sub-area boundary	One-way route
	Two-way route	Vehicle parking	Camps

Ad hoc military training is known to have occurred in D-Day Marshalling Areas. No records have been found to indicate that any such training took place on the Site and no evidence of military training has been identified on historical aerial photography (see Plates 2 and 3).

After WWII, Marshalling Area 'C' was disbanded.

Marshalling Area 'C' is not considered to provide a significant source of UXO hazard to the Site.

3.2 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- [redacted]

No military defences have been identified on the Site. The nearest are described below.

3.2.1 Anti-Aircraft (AA) guns

During WWI there was 1No. AA battery recorded within 10km of the Site. It was located at Midanbury (SU 444686), approximately 8km south of the Site. It was armed with 1No. 18-pdr gun.

During WWII there were 8No. Heavy AA (HAA) batteries recorded within 10km of the Site. The nearest was located at Bishopstoke (SU 474201), approximately 1.4km southeast of the Site. Its armament is unknown.

The nearest recorded WWII AA shell incidents to the Site are described below.

28th March 1944

1No. AA shell fell on Main Road, approximately 0.4km west of the Site. This was recorded as an Unexploded AA (UXAA) shell and removed.

23rd June 1944

1No. AA shell fell on a field, west of the SWML railway, approximately 0.1km south of the Site. This was recorded as an UXAA shell and removed.

Potential UXO hazard

Given the number of AA gun batteries in the surrounding area, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

3.3.2 Bombing decoys

The nearest recorded bombing decoy was located at Hursley (SU 452254), approximately 2.5km north-northwest of the Site.

Bombing decoys are not considered to provide a source of UXO hazard to the Site.

3.3 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any military airfields on or in close proximity to the Site have been found.

During WWI, the nearest operational airfield was Eastleigh Aerodrome, approximately 4.8km south of the Site. It was established in 1917 as an Aircraft Acceptance Park (AAP) for use by the Royal Flying Corps (RFC). In July 1918 Eastleigh Aerodrome became a US Navy Air Station and was developed as a base for future bombing operations.

By April 1919 Eastleigh Aerodrome had transferred to civilian and commercial use, and later became Southampton Municipal Airport.

During WWII, the nearest operational airfield was Marwell Hall Airfield, approximately 3.2km east of the Site. It opened in September 1941 as a dispersed storage airfield for aircraft produced and modified at the Cunliffe Owen Aircraft factory, approximately 4.1km south of the Site.

Marwell Hall Airfield stored modified British and US military aircraft, including Supermarine Seafire fighter aircraft, Bell P39 Airacobra fighter aircraft, and Handley Page Halifax heavy bomber aircraft.

By March 1944 Marwell Hall Airfield had closed and returned to civilian use.

Military airfields are not considered to provide a source of UXO hazard to the Site.

3.4 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

- [redacted]

No records of any aircraft crashes on or in close proximity to the Site have been found.

3.5 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]

No records of any explosives factories, munitions depots or munitions disposal areas on or in close proximity to the Site have been found.

3.6 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

No records of any firing ranges or military training areas on or in close proximity to the Site have been found.

4 BOMBING

4.1 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.1 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWI.

4.2 [redacted]

For further information on [redacted] in the UK, and the potential UXO hazard associated with it, see Appendix 2.2 or use the following link.

- [redacted]

No records have been found indicating that the Site was bombed during WWII. Details of [redacted] in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Hampshire

Bombing raids began in the summer of 1940 and continued until the end of WWII. Over one-third of the total number of bombs falling in Hampshire fell on Southampton and Portsmouth over 10km south of the Site.

The Luftwaffe was aware of the docks, military bases, army camps, barracks, and industrial sites in Hampshire. Operational airfields in Hampshire were deliberately targeted by the Luftwaffe including RAF Southampton, approximately 4.1km south of the Site.

During WWII Southampton, approximately 10km south of the Site, was an important Luftwaffe target because of its docks, aircraft manufacturing works, and other industries important to the war effort. Bombing densities greatly decreased further inland.

Bombing densities significantly decreased in the surrounding rural districts, with raids mainly carried out by single aircraft dropping small numbers of bombs or jettisoning unused payloads.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic targets

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets.

The Site was located in an area which contained numerous strategic targets, including Marwell Hall Airfield (see Section 3.3), aircraft manufacturing, and military barracks, camps, and training areas.

The nearest designated Luftwaffe target was Marwell Hall Airfield, approximately 3.2km east of the Site.

4.2.3 Bombing densities and incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

<5 bombs per 405ha is a Very Low regional bombing density.

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Note that Table 1 excludes the figures for V1s, V2s, and IBs. Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Winchester RD	**795**	**19**	**26**	**840**	**7.6**
Southampton CB	2,510	30	12	2,552	277.6
Eastleigh MB	160	10	3	173	27.6
Droxford RD	599	38	26	663	10.6
Romsey & Stockbridge RD	679	74	26	779	9.3
Winchester MB	15	0	0	15	3.9

It should be noted that during WWII, many Unexploded Bombs (UXBs) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

27th September 1940

1No. High Explosive (HE) bomb fell on Main Road, approximately 0.3km west-northwest of the Site. This was recorded as a UXB and removed.

17th November 1940

1No. HE bomb fell on fields opposite the Dog & Crook public house, approximately 0.4km east of the Site.

18th November 1940

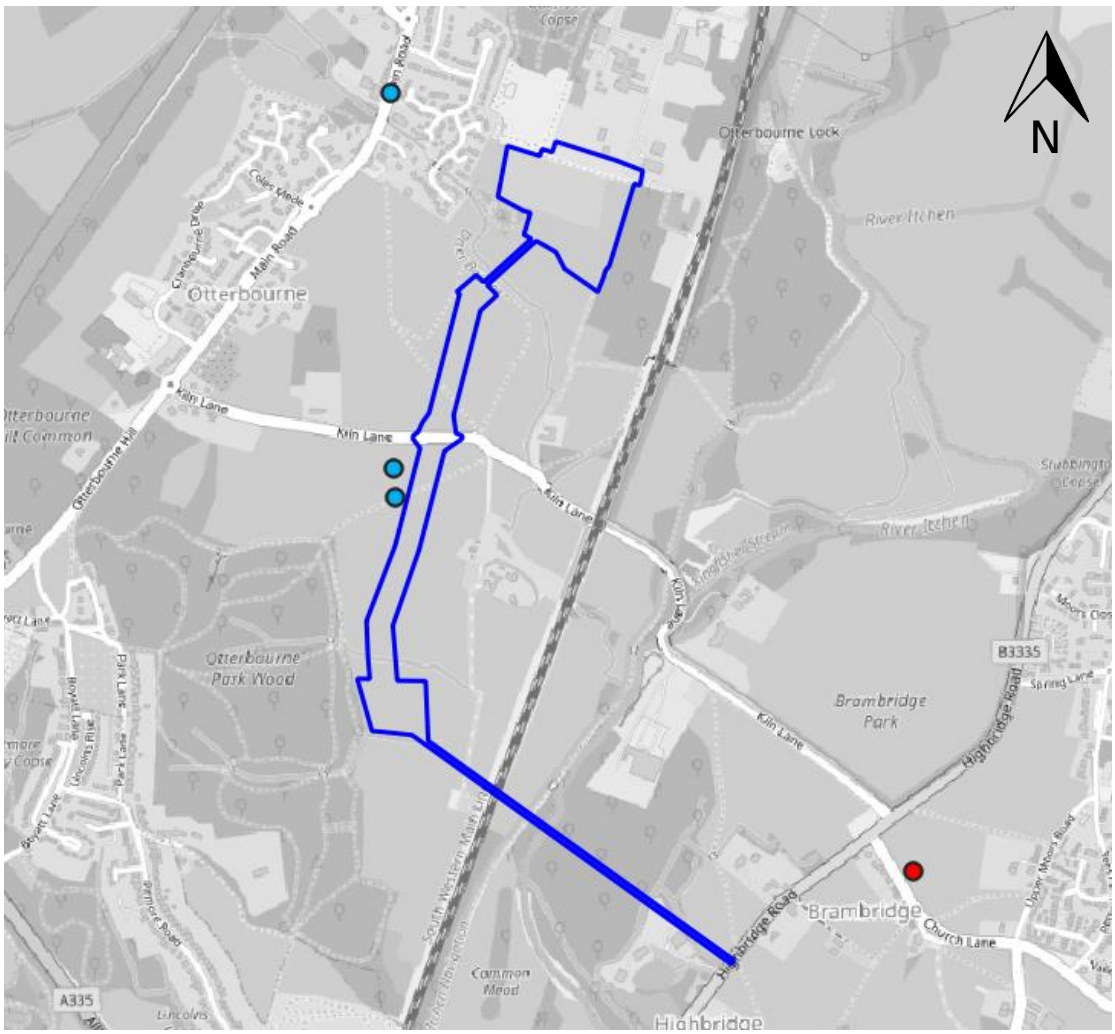
2No. HE bombs fell on a field between Kiln Road and Manor Farm, adjacent to the western boundary of the Site. These were recorded as UXBs and were removed on the 28th November 1940.

Figure 3 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P14032-24-R3-MAP01-A.

Figure 3 Compiled bomb impact map for the vicinity of the Site

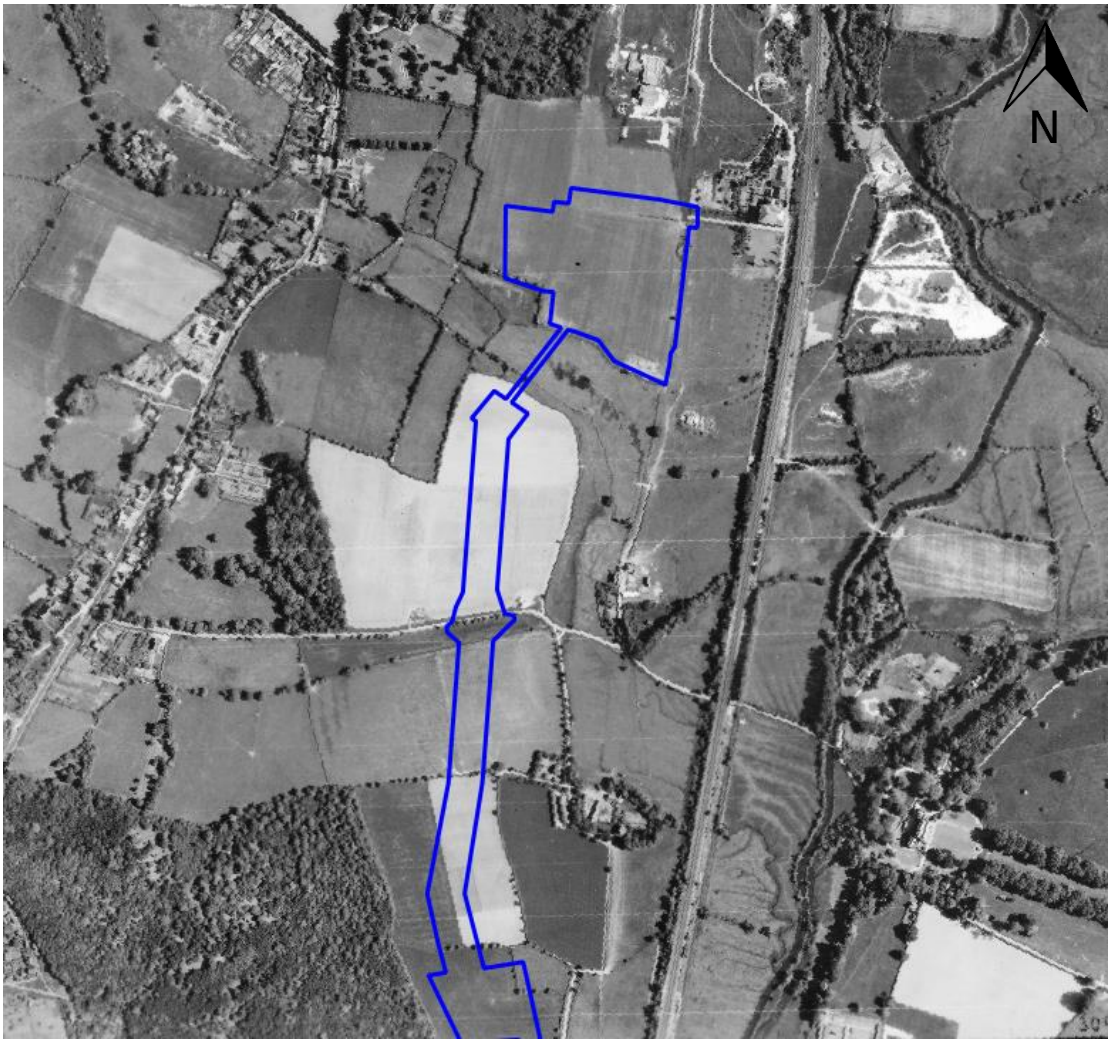


Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	UXB

Plate 2 and 3 are aerial photographs of the Site dated the 28th May 1947. No bomb damage or cratering has been identified on or in the vicinity of the Site.

Plate 2 Aerial photograph of the northern part of the Site, 28th May 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Plate 3 Aerial photograph of the southern part of the Site, 28th May 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO hazard

No records have been found indicating that the Site was bombed and no bomb damage has been identified on the Site on historical aerial photography.

[redacted] is not considered to provide a significant source of UXO hazard to the Site.

4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site.

4.2.5 Bomb penetration depths

At the time of writing, no Site-specific ground investigation data was provided.

BGS 1:50,000 Sheet Southampton (Solid & Drift) and BGS borehole records from nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of open ground, over alluvium deposits of clay, silt, sand, and gravel, overlying the Lambeth Group.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 4m of soft clay over more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	6.5m
	250kg	9.0m
	500kg	14.5m

These calculations can be refined on receipt of Site-specific information.

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).

b) A strike angle of 10 to 15 ° to the vertical.

c) That the bomb is stable, both in flight and on penetration.

d) That no retarding units are fitted to the bomb.

e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth. If hardstanding or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (approximately 11%) were recorded as UXBs. However, records from the Royal Engineers (RE) who were responsible for bomb disposal at the time indicate that by 27th February 1946, more than 45,000No. UXBs were disposed of.

On average, 8.5% of UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear. Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office (WO) statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

5.1 EOC tasks

Zetica holds no records of post-WWII EOC tasks having taken place on or in the vicinity of the Site.

6 UXO HAZARD ASSESSMENT

6.1 UXO hazard level

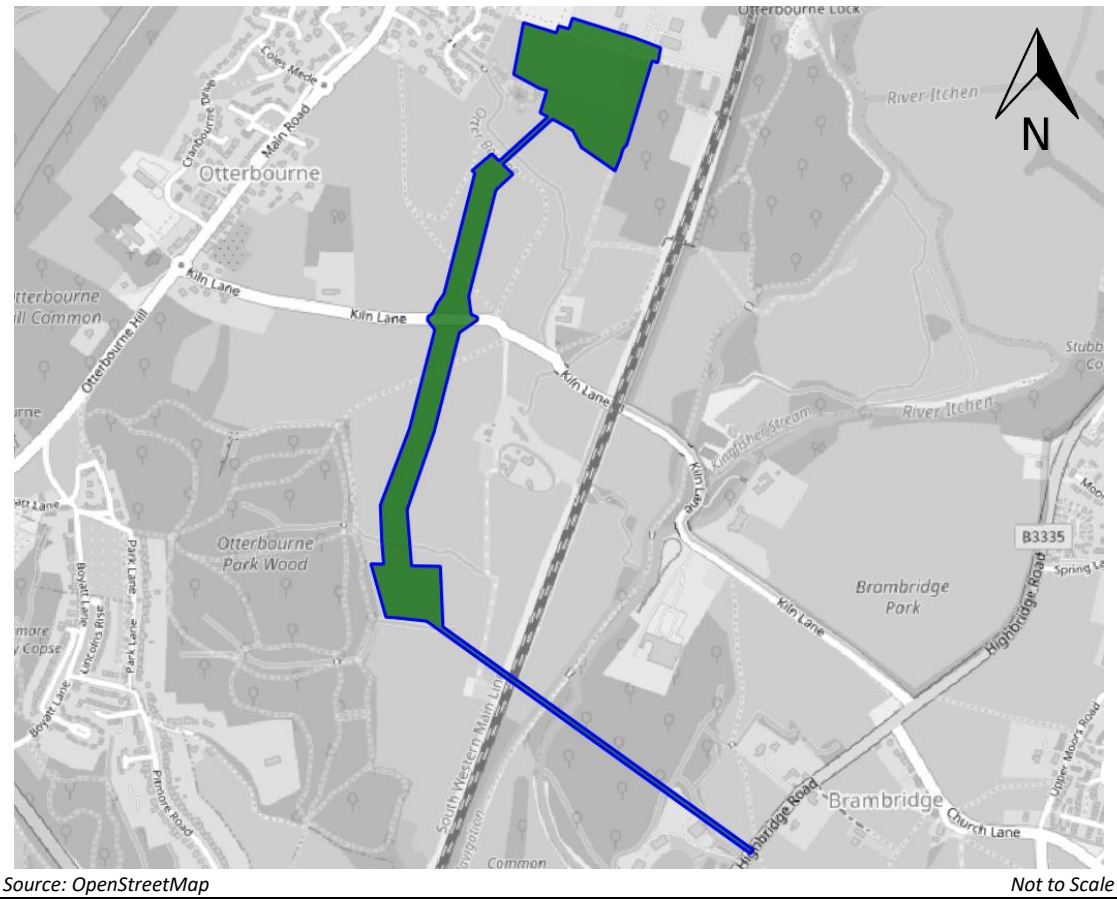
Definitions of UXO Hazard Level for a Site	
Hazard Level	**Definition**
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present or that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.

No records have been found indicating that the Site was bombed and no other significant sources of UXO hazard have been identified on the Site.

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 4.

The UXO hazard zone plan of the Site is also given in the accompanying P14032-24-R3-MAP01-A.

Figure 4 UXO hazard zone plan of the Site



Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate	
	High		Very High		Site boundary	

7 UXO RISK ASSESSMENT

7.1 Proposed works

It is understood that works on the Site are associated with the construction of an underground pipeline. Works will comprise open cut excavations to 6m below ground level (bgl) and Horizontal Directional Drilling (HDD) to 20m bgl.

7.2 Risk assessment methodology

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard(s).

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating an item of UXO (PD) has been considered and rated for the proposed construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0
P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.		

The likelihood of encountering and detonating UXO during site works (P) is multiplied by the severity (S) of such an event occurring (P x S), to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
	SEVERITY (S)						
LIKELIHOOD (P)		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 3.

Table 3 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Excavations	1	1	1	1	5	5	Low
	HDD	1	1	1	1	4	4	Low
Other UXO	Excavations	1	1	1	1	4	4	Low
	HDD	1	1	1	1	3	3	Low
PE = Probability of Encounter; PD = Probability of Detonation; P = Likelihood								
HDD – Horizontal Directional Drilling								

8 RISK MITIGATION PLAN

Key findings: No significant sources of UXO hazard have been identified.

Key actions: Proceed with works. An UXO awareness briefing is prudent for staff involved in excavations.

8.1 UXO risk summary

Table 4 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 4 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		**Proceed with works** – an UXO awareness briefing is prudent for staff involved in excavations.
HDD		**Proceed with works**

In summary, no additional measures are considered essential to reduce the UXO risk on the Site to As Low As Reasonably Practicable (ALARP). An UXO awareness briefing for staff involved in excavations is always prudent.

8.2 Risk mitigation techniques

8.2.1 UXO awareness briefing

It is prudent that all staff involved in intrusive works are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

An UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.

8.3 What do I do next?

If you have any comments or require further assistance, contact us and we can help.

 **01993 886682**  [redacted]  [redacted]

If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a re-assessment of the UXO risk and the risk mitigation requirements.

APPENDICES

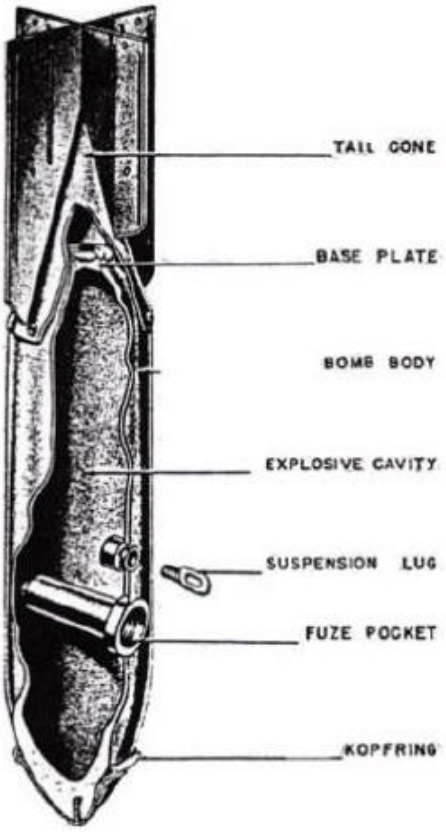
Appendix 1 Anticipated ordnance types

For a more comprehensive set of ordnance data sheets, see [redacted]

Information Data Sheet

Category Bomb (Luftwaffe)
Type Sprengbombe-Cylindrisch (SC) 50kg

Variants	8
Body Dimensions	762 x 200mm (30" x 7.9")
Weight	55kg (122lbs)
Charge Weight	25kg (54lbs)
Fuze	Single electric impact fuze. Some have short time delay
Composition	Sheet steel
Description	Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



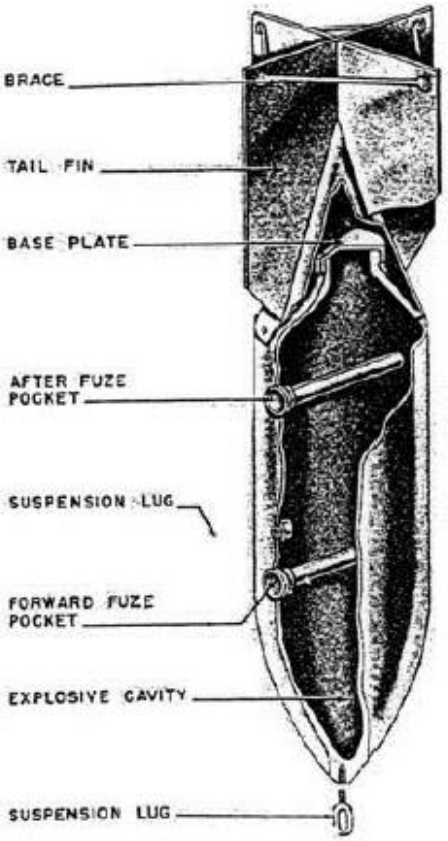




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring) or spike. Sheet metal tail attached to body with rivets/ screws. Suspension eye bolt in the nose/body. Originally painted green-grey with a yellow stripe on the tail. TNT; amatol; TNT and aluminium powder, naphthalene, ammonium nitrate and wax/ wood meal filling.
Function	Designed to maximise shock waves through air, water and earth and general demolition. Used against railway installations, large buildings, ammunition depots and below-ground installations (to 8m). Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) used against rail lines and country roads.



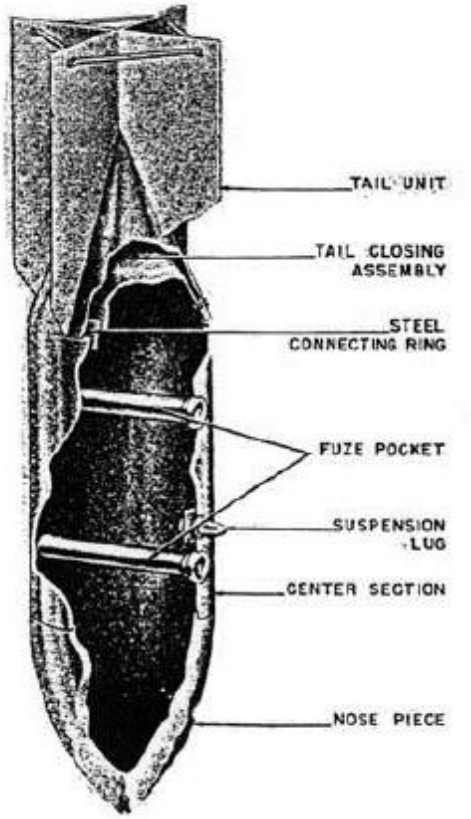




Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose may be attached to Kopfring (triangular section steel ring). Tail either steel sheet or drum-shaped. Suspension band. Originally painted green-grey/ buff (some later versions sky blue) with yellow stripe on tail. Filled with amatol, TNT or trialen.
Function	Designed to maximise shock waves through air, water and earth and for general demolition. Used against railway property, large buildings, shipping and below-ground installations.







Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

Variants 6

Body Dimensions 94mm x 360mm (3.7 x 14.7")

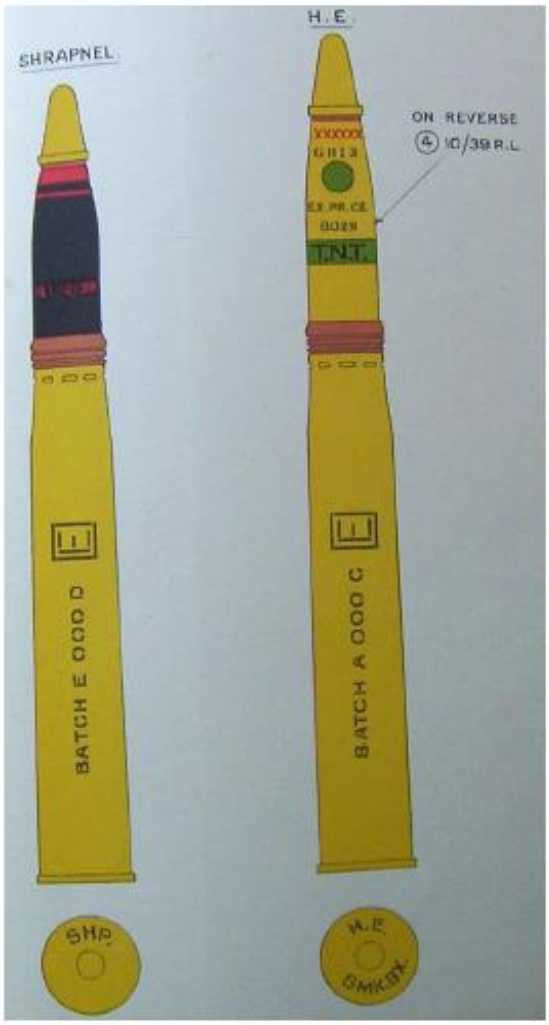
Weight 12.7kg (28lb)

Fuze Mechanical time fuze

Composition Cast steel

Description Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.

Function Used as a defence against enemy aircraft, fired from fixed batteries and mobile mountings. Could fire approximately 20 rounds per minute with a maximum ceiling of 41,000ft and horizontal range of 20,600 yards.



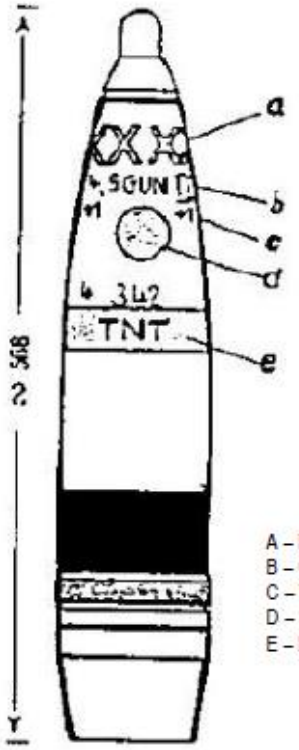




Information Data Sheet

Category Projectile
Type 4.5" Shell (Mark II – Anti-Aircraft)

Variants	-
Body Dimensions	114mm x 566mm (4.5" x 21.9")
Weight	24.9kg (55lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Square-based, tapered-nosed shell filled with TNT or Amatol. Steel casing, rotating band of either copper or gilding metal located 3.5" in front of the base end with single groove.
Function	Used as field artillery and adapted for use in anti-aircraft defence from fixed batteries. Rate of fire of 8 rounds per minute, maximum ceiling of 44,000ft and horizontal range of 22,800 yards.



A – Missile Identification
B – Gun and Bullet Type
C – Weight
D – Smoke pot







Appendix 2 Sources of UXO hazard

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see [redacted]

Appendix 2.1 [redacted]

Information Data Sheet

Category World War One (WWI) Bombing

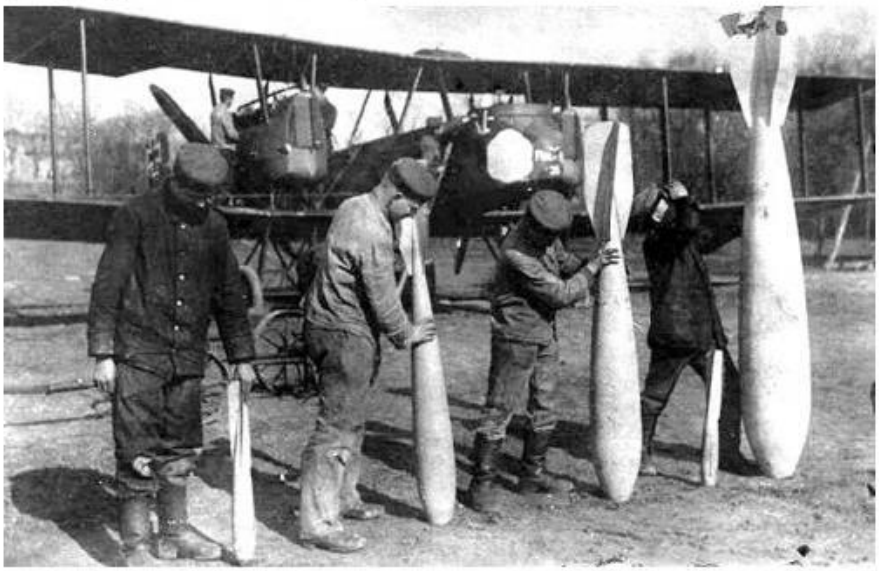
Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21st December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19th May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.

Appendix 2.2 [redacted]

Information Data Sheet

Category World War Two (WWII) Bombing

Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.

In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs aimed at a specific location might not just miss the intended target but could fall a considerable distance away.

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- Was the site bombed and how heavy were the raids?
- Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.

Appendix 2.3 Anti-Aircraft defences

Information Data Sheet

Category Anti-Aircraft (AA) Defences

Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.



WWI 3-pdr mobile Vickers AA gun



WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) – typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) – typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) – fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km. These tended to be permanent gun emplacements.

Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.

Appendix 3 Recent UXO finds

Information Data Sheet

Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

Explosives rarely lose effectiveness with age. In some instances, mechanisms such as fuzes and gaines can become more sensitive and more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay, or similar materials.

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 26th February 2021, a 1,000kg German "Hermann" UXB was discovered by builders at Exeter University campus (see below). It was investigated and detonated in-situ following the evacuation of nearby properties and University halls of residence.



1,000kg German UXB discovered in Exeter, 2021

On the 29th March 2021, 1No. 250lb UXB was discovered on the seabed near Hinkley Point C harbour, Bristol. A maritime exclusion was imposed while the item was investigated and then destroyed in a controlled explosion.

On the 1st June 2021, a cache of approximately 100No. WWII-era hand grenades were found in a Nottinghamshire forest, a possible relic from nearby WWII camps. They were destroyed.

On the 24th July 2021, 1No. 500lb British UXB was uncovered during construction works in Goole, East Yorkshire. Reports indicated that the UXB had been jettisoned by a Lancaster bomber aircraft prior to crashing nearby in WWII. The item was investigated and destroyed.

On the 18th August 2021, 1No. UXB was found by construction workers on a Site in Earl Sterndale, Derbyshire. Upon inspection the UXB was deemed to be dangerous, and a controlled detonation was undertaken.

On the 10th September 2021, EOD teams destroyed 25No. mortar bombs which had been washed up onto beaches around Nairn and Ardersier in Morayshire. These beaches had been used during WWII for training prior to the D-Day landings in Normandy.



Mortar bombs found on beaches in Nairn and Ardersier, 2021

On the 15th December 2021, approximately 200No. artillery shells were discovered at a construction site located within the former Royal Ordnance Factory at Swynnerton in Staffordshire. The shells were removed and destroyed.

On the 2nd January 2022, 1No. heavily deteriorated 105mm artillery shell was discovered by dogwalkers on a beach in Cumbria. This may have originated on one of the several offshore ranges which have been operational along the nearby coastline since WWII.

Between the 24th and 27th January 2022, 5No. empty artillery shells were uncovered at a construction site in Manchester. These were likely linked to a shell-production factory which had been active on the site during WWII.

On the 14th July 2022, 1No. 2" mortar bomb and several Small Arms Ammunition rounds were discovered on a beach near Ardnamurchan. An EOD team disposed of the items.

On the 28th November 2022, 45No. Self-Igniting Phosphorus grenades were discovered during construction works at a school in Swindon. They were disposed of by an EOD team.

On the 5th December 2022, 1No. UXB was discovered during construction at Biggin Hill Airport. An EOD team removed the UXB for safe disposal.

On the 7th February 2023 1No. 250kg bomb was found during dredging works in the River Yare, Great Yarmouth. It detonated unplanned whilst being disarmed by an Army EOD team.

On the 17th April 2023, 1No. unexploded mortar bomb was discovered at Cavenham Heath Nature Reserve. It was destroyed in a controlled explosion by an EOD team. This followed 2No. other similar discoveries on the 7th March and 12th March in the same stretch of canal.

On the 27th July 2023, 1No. 250kg WWII bomb was discovered off the coast of Guernsey by a recreational diver. It was detonated in situ by a Royal Navy EOD diver team.

Appendix 4 Glossary and definitions

Abandoned Explosive Ordnance (AXO)	Explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Demil	Derived from the term 'Demilitarisation', demil refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame, and a shock wave.
Device	Any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells, or bombs.
Explosive	Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.
Explosive Ordnance Clearance (EOC)	The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.
Explosive Ordnance Disposal (EOD)	The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.
Explosive Ordnance Reconnaissance (EOR)	The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.
Explosive Remnants of War (ERW)	Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.
Explosive Substances & Articles (ESA)	Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction. One or more explosive substances form an explosive article.

Fuze	The part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and especially in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
Geophysical survey	A range of methods that can be used to detect objects or identify ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as disturbance of ordnance is to be avoided where possible.
High Explosive (HE)	Secondary explosives (commonly known as HE) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are Nitro-glycerine (NG), Trinitrotoluene (TNT), Amatol (Ammonium nitrate and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).
Land Service Ammunition (LSA)	Items of ordnance thrown, propelled, or placed during land warfare, to include grenades, mortar bombs, projectiles, rockets, and landmines.
Munition	The complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training, ceremonial, or non-operational purposes. These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired but failed to function as intended.)
Primary Explosive	Explosives used to initiate less sensitive explosives and usually extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are lead azide, lead styphnate, and mercury fulminate.
Propellants	Provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure, and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are ballistite, often in flake form, and cordite, often in string form.
Pyrotechnic	An explosive article or substance designed to produce an effect by heat, light, sound, gas, or smoke (or a combination), as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Small Arms Ammunition (SAA)	Projectiles around 12mm or less in calibre and no longer than approximately 100mm. They are fired from a variety of weapons, including rifles, pistols, shotguns, and machine guns.

Unexploded Anti-Aircraft (UXAA) Shell	Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.
Unexploded Bomb (UXB)	A common term for unexploded air-dropped munitions.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fuzed, armed, or prepared for use and subsequently fired, dropped, launched, projected, or placed in such a manner as to present a hazard to operations, persons, or objects, and remains unexploded either by malfunction or design.
V1	The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the forerunner of today's cruise missile.
V2	The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object launched into space, during test flights in 1944.

Appendix 5 Bibliography

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, Land Contamination: Technical Guidance on Special Sites: MoD Land

Bulloch G, Steeds J E, Green K, Sainsbury M G, Brockwell J S & Slade N J, R&D Technical Report P5-042/TR/03, Land Contamination: Technical Guidance on Special Sites: Explosives Manufacturing & Processing Sites

Brookes R J, Airfields in the Second World War, Hampshire, 1996

CIRIA, Unexploded Ordnance (UXO), a Guide for the Construction Industry, 2009

Clarke N J, Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942, 1996

Cocroft W D, Dangerous Energy, 2000

Cocroft W D, Thomas R J, Cold War, 2003

Department of the Environment, Sampling Strategies for Contaminated Land, Department of the Environment: Contaminated Land Research Report, CLR Report No. 4, 1994

Dobinson C S, Twentieth Century Fortifications in England, Vols I – XI, Council for British Archaeology, 1996

Dobinson C S, Fields of Deception, Britain's Bombing Decoys of World War II, 2000

Dobinson C S, AA Command, 2001

Morris J, German Air Raids on Britain 1914-1918, 1993

Price A, Blitz on Britain 1939-45, 2000

Ramsey W, The Blitz Then and Now, Vol 1, 1987

Ramsey W, The Blitz Then and Now, Vol 2, 1988

Ramsey W, The Blitz Then and Now, Vol 3, 1990

Rowlands M, Hampshire at War 1939-45, 2018

Zetica, ZeticaUXO Handbook: a guide to dealing with UXO during construction, 2018

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More details are available at

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