# Detailed Unexploded Ordnance (UXO) Threat & Risk Assessment

Meeting the requirements of *CIRIA C681 ‘Unexploded Ordnance (UXO) A guide for the Construction Industry’ Risk Management Framework*

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6 Alpha Project Number: SAMPLE  
Landmark Order Number: SAMPLE  
Client Reference: SAMPLE

| **Site** | Parsons North, Edgware Road, London, W2 1NE |
| **Rating** | **MEDIUM** - This Site requires limited further action to reduce risk to ALARP during intrusive activities. |

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**6 Alpha Project Number**: SAMPLE  
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Acronyms and Abbreviations

AA  Anti-Aircraft
AAA  Anti-Aircraft Ammunition
AAC  Army Air Corps
AFS  Advanced Flying School
ALARP  As Low As Reasonably Practicable
AOD  Above Ordnance Datum
ARP  Air Raid Precaution
ATS  Auxiliary Territorial Service
AXO  Abandoned Explosive Ordnance
BD  Bomb Disposal
BDO  Bomb Disposal Officer
BGS  British Geological Survey
BH  Borehole
BPD  Bomb Penetration Depth
CDP  Cast Driven Piles
CFA  Continuous Flight Auger
CIRIA  Construction Industry Research and Information Association
CPT  Cone Penetration Testing
CS  County Series
EFTS  Elementary Flying Training School
ELG  Emergency Landing Ground
EO  Explosive Ordnance
EOC  Explosive Ordnance Clearance
EOD  Explosive Ordnance Disposal
ERW  Explosive Remnants of War
FAA  Fleet Air Arm
FPP  Flight Pilot Pool
FTS  Flight Training School
GI  Ground Investigation
GIS  Geographic Information Systems
GL  Ground Level
GP  General Purpose
GPS  Global Positioning Systems
HAA  Heavy Anti-Aircraft
HE  High Explosive
HO  Home Office
HSE  Health and Safety Executive
IB  Incendiary Bomb
IED  Improvised Explosive Device
JSEODOC  Joint Service Explosive Ordnance Disposal Operations Centre
kg  Kilograms
km  Kilometres
LAA  Light Anti-Aircraft
lb  Pounds
LCC  London County Council
LDV  Local Defence Volunteers
LE  Low Explosive
LSA  Land Service Ammunition
m  Metres
MACP  Military Aid to the Civil Power
MoD  Ministry of Defence
mm  Millimetres
NATO  North Atlantic Treaty Organisation
NEQ  Net Explosive Quantity
NFF  National Filling Factory
NGR  National Grid Reference
OD  Ordnance Datum
OS  Ordnance Survey
OTU  Operational Training Unit
PBG  Polar Blasting Gelignite
PM  Parachute Mine
PoW  Prisoner of War
RADAR  Radio Detection And Ranging
RAF  Royal Air Force
RBL  Rifle Breach Loaded
RDX  Research Department Explosives
RFC  Royal Flying Corps
RML  Rifle Muzzle Loaded
RN  Royal Navy
RNAS  Royal Naval Air Service
ROF  Royal Ordnance Factory
SAA  Small Arms Ammunition
Sq  Squadron
TA  Territorial Army
TNT  Trinitrotoluene
UK  United Kingdom
UN  United Nations
USAAF  United States Army Air Force
UXB  Unexploded Bomb
UXO  Unexploded Ordnance
V Weapons  Vergeltungswaffe – Vengeance
WAAF  Women’s Auxiliary Air Force
WD  War Department
WWI  World War One
WWII  World War Two
EXECUTIVE SUMMARY

Study Site

The Client has defined the Study Site as “Parsons North, Edgware Road, London, W2 1NE”. The Site is located at NGR 526630, 182110.

Risk Level

MEDIUM

Potential Threat Sources

The most probable UXO threat is posed by WWII German HE bombs, whilst IBs and British AAA projectiles (which were used to defend against German bombing raids) pose a residual threat.

Risk Pathway

Given the types of UXO that might be present on-site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.

Key Findings

During WWII, the Study Site was situated within Paddington Metropolitan Borough and St. Marylebone Metropolitan Borough, which recorded 54 and 67 HE bombs per 100 hectares respectively, both very high levels of bombing.

Luftwaffe aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m of it. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets.

ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; the closest of which was located 30m to the south-east. In addition, a UXB disposal task was recorded 125m to the north-west of the Site. Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

An analysis of the LCC maps associated with the Site shows “blast damage, minor in nature” and “general blast damage – not structural” to buildings within the Site boundary. In addition, “damage beyond repair” and “total destruction” was recorded to buildings located immediately south of the Site. Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous “ruins” within the Site’s vicinity, which is likely to be attributed to bombing.

Pre-WWII mapping (1938) and aerial photography (1945) associated with the Site shows that it was located within a densely developed urban area during WWII and comprised residential housing and a milk depot. Therefore, it is plausible that a local resident would have observed and reported any UXB entry hole following any raids. However, given the development of the Site combined with the bomb damage recorded, it is considered probable that UXB entry holes may have been masked by bomb damage debris, and therefore may have gone unnoticed.

In the early 1970s, all structures were demolished from the Site and superseded with a basement car park, which covers the entire Site. As a result, it is highly likely that any UXO within the structural footprint of the basement car park would have been discovered and removed; however, the potential for deep buried UXO to be present below these foundations is assessed to remain remotely extant. The client has stated the proposed works will be carried out within the footprints of the existing post-war basement car park and therefore within previously disturbed ground i.e. that which has been previously excavated, probed, drilled or otherwise intrusively disturbed since it had potentially become contaminated with UXO. As a result, the risk of UXO discovery at this Site has been mitigated. However, if works are to extend below the existing basement, 6 Alpha should be informed so that the risk can be recalculated and the appropriate mitigations can be applied.
EXECUTIVE SUMMARY (...continued)

Recommended Risk Mitigation

All Groundworks in All Areas:

1. Operational UXO Risk Management Plan; appropriate Site Management documentation should be held on-site to guide and plan for the actions which should be undertaken in the event of a suspected or real UXO discovery, (this plan can be supplied by 6 Alpha);

2. UXO Safety & Awareness Briefings; the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the Site should receive a briefing on the identification of a UXB, what actions they should take to keep people and equipment away from such a hazard and to alert Site management. Information concerning the nature of the UXB threat should be held in the Site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The safety and awareness briefing is an essential part of the Health & Safety Plan for the Site and helps to evidence conformity with the principles laid down in the CDM regulations 2015, (this briefing can be supplied by 6 Alpha).

For further information, please contact Envirocheck:

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**ASSESSMENT METHODOLOGY**

**Approach**

6 Alpha Associates is an independent, specialist risk management consultancy practice, which has assessed the risk of encountering UXO (as well as buried bulk high explosives) at this Site, by employing a process advocated for this purpose by CIRIA. The CIRIA guide for managing UXO risks in the construction industry (C681) not only represents best practice but has also been endorsed by the HSE. Any risk mitigation solution is recommended only because it delivers the Client a risk reduced to ALARP at best value.

UXO hazards can be identified through the investigation of local and national archives associated with the Site, MoD archives, local historical sources, historical mapping as well as contemporaneous aerial photography (if it is available). Hazards will have only been recorded if there is specific information that could reasonably place them within the boundaries of the Site. The amalgamation of information is then assessed to enable the researcher to provide relevant and accurate risk mitigation practices.

The assessment of UXO risk is a measure of probability of encounter and consequence of encounter; the former being a function of the identified hazard and proposed development methodology; the latter being a function of the type of hazard and the proximity of personnel (and/or other ‘sensitive receptors’, such as equipment) to the hazard, at the moment of encounter.

If UXO risks are identified, the methods of mitigation we have recommended are considered reasonably and sufficiently robust to reduce them to ALARP. We advocate the adoption of the legal ALARP principle because it is a key factor in efficiently and effectively ameliorating UXO risks. It also provides a ready means for assessing the Client’s tolerability of UXO risk. In essence, the principle states that if the cost of reducing a risk significantly outweighs the benefit, then the risk may be considered tolerable. This does not mean that there is never a requirement for UXO risk mitigation, but that any mitigation must demonstrate that it is beneficial. Any additional mitigation that delivers diminishing benefits and that consume disproportionate time, money and effort are considered de minimis and thus unnecessary. Because of this principle, UXB and UXO risks will rarely be reduced to zero (nor need they be).

**Important Notes**

Key source material is referenced within this document, whilst secondary/anecdotal information may be available upon request.

Although this report is up to date and accurate at the time of writing, our databases are continually being populated as and when additional information becomes available. Nonetheless, 6 Alpha have exercised all reasonable care, skill and due diligence in providing this service and producing this report.

The assessment levels are based upon our professional opinion and have been supported by our interpretation of historical records and third party data sources. Wherever possible, 6 Alpha has sought to corroborate and to verify the accuracy of all data we have employed, but we are not accountable for any inherent errors that may be contained in third party data sets (e.g. National Archive or other library sources), and over which 6 Alpha cannot exercise control.
STAGE ONE – SITE LOCATION AND DESCRIPTION

Study Site

The Client has described the Study Site as “Parsons North, Edgware Road, London, W2 1NE”. The Site is located at NGR 526630, 182110. The Site location and Site boundary are presented at Figures 1 and 2 respectively.

Location Description

The Study Site is situated within the Metropolitan Boroughs of Paddington and St. Marylebone and covers an area of 0.21 hectares (ha).

Furthermore, the Site is bounded by:

- Northwest: Crompton Street;
- Northeast: Edgware Road;
- Southeast: Parsons House and hardstanding;
- Southwest: Hall Place.

Aerial Photography (Current) (Figure 3)

Current aerial photography shows that the Site is situated within a densely developed urban area and consists of hardstanding concrete, which serves as the roof of a basement car park below.

Proposed Works

The Client provided the following information regarding the works that will be carried out:

- Breaking out of the roof and columns of existing car park to slab level;
- Installation of piles;
- The new building is a five-storey structure plus basement car park within the same footprint and to the same ground level as the existing car park.

As a result, 6Alpha will assume that excavations and piling will be carried out within current foundations and in particular within the curtilage of the existing building and previously disturbed ground.

Ground Conditions

It is important to establish the specific ground conditions in order to determine the maximum German UXB penetration depth as well as the potential for other types of munitions to be buried.

If the Site investigations and/or construction methodologies change, and/or if a specific methodology is to be employed, and/or if the scope of work is focused upon a specific part of the Site, then 6 Alpha are to be informed so that the prospective UXO risks and the associated risk mitigation methodology might be re-assessed. Certain ground conditions may also constrain certain types of UXO risk mitigative works e.g. magnetometer survey is adversely affected in mineralised and made ground.

The Client has described the ground conditions as follows: ‘Hackney Gravel Member over London Clay. Site is currently a basement car park.’
STAGE ONE – SITE LOCATION AND DESCRIPTION (...continued)

Ground Conditions
BGS borehole log “TQ28SE356 – G.P.O. BH8 St. Marylebone” (located 50m to the northwest), recorded the following strata

<table>
<thead>
<tr>
<th>Depth bgl (m)</th>
<th>Strata</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0m to 3.05m</td>
<td>Fill</td>
<td>Hardcore and rubble, stiff mottled brown clay</td>
</tr>
<tr>
<td>3.05m to 3.35m</td>
<td>Clay</td>
<td>Soft-firm mottled brown clay</td>
</tr>
<tr>
<td>3.95m to 6.85m</td>
<td>Clay</td>
<td>Stiff fissured mottled brown clay, containing gypsum crystals</td>
</tr>
<tr>
<td>6.85m to 7.15m</td>
<td>Clay</td>
<td>Stiff mottled brown-blue clay</td>
</tr>
<tr>
<td>7.15m to 45m</td>
<td>Clay</td>
<td>Very stiff fissured blue silty clay containing occasional gypsum crystals and claystone boulders.</td>
</tr>
</tbody>
</table>
### STAGE TWO – REVIEW OF HISTORICAL DATASETS

#### Sources of Information Consulted

The following primary information sources have been used in order to establish the background UXO threat:

1. 6 Alpha’s Azimuth Database;
2. Home Office WWII Bomb Census Maps;
3. WWII and post-WWII aerial photography;
4. Official Abandoned Bomb Register;
5. LCC Bomb Damage maps;
6. Information gathered from the National Archives at Kew;
7. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.

#### Potential Sources of UXO Contamination

In general, there are several activities that might contaminate a site with UXO but the three most common ways are:

- Legacy munitions from military training/exercises;
- Deliberate or accidental dumping (AXO) and ordnance resulting from war fighting activities (also known as the Explosive Remnants of War (ERW)).

During WWII, the Luftwaffe undertook bombing campaigns all over the UK. The most common type of UXO discovered today is the aerially delivered high explosive (HE) bomb, which are comparatively thick-skinned and dropped from enemy aircraft. If the bomb did not detonate when it was dropped, the force of impact enabled the UXO to penetrate the ground, often leaving behind it a UXB entry hole. These entry holes were not always apparent and some went unreported, leaving the bomb buried and unrecorded. More rarely, additional forms of German UXO are occasionally discovered including *inter alia* V1 and V2 rockets, Incendiary Bombs (IBs), and Anti-personnel (AP) bomblets.

Although the Luftwaffe had designated primary bombing targets across the UK, their high-altitude night bombing was not accurate. As a result, thousands of buildings were damaged and civilian fatalities were common. Bombs were also jetisoned over opportunistic targets and residential areas were sometimes struck.

As the threat of invasion lingered over Britain during WWII, defensive actions were undertaken. The British and Allied Forces requisitioned large areas of land for military training and bomb storage (including HE bombs, naval shells, artillery and tank projectiles, explosives, LSA and SAA). Thousands of tonnes of these munitions were used for the Allied Forces weapon testing and military training alone. It has been estimated that at least 20 per cent of the UK’s land has been used for military training at some point.

*The best practice guide for dealing with your UXO risks on land* (CIRIA publication C681) suggests that approximately 10 per cent of all munitions deployed failed to function as designed. ERW are therefore, still commonly encountered, especially whilst undertaking construction and civil engineering groundwork.

Furthermore, in exceptional circumstances, UXO is discovered unexpectedly and without apparent rational explanation. There are several ways this might occur:

- When *Luftwaffe* aircraft wished to swiftly escape e.g. from an aerial attack, they would jettison some or all of their bombs and flee. This is commonly referred to as *tip and run* and it has resulted in bombs being found in unexpected locations;
- Transportation of aggregate containing munitions to an area that was previously free of UXO, usually related to construction activities employing material dredged from a contaminated offshore borrow site;
- Poor precision during targeting (due to high altitude night bombing and/or poor visibility) resulted in bombs landing off target, but within the surrounding area.
- *British* decoy sites were also constructed to deliberately cause incorrect targeting. For obvious reasons, such sites were often built in remote and uninhabited areas.
STAGE TWO – REVIEW OF HISTORICAL DATASETS (...continued)

Site History
From an analysis of the CS and OS historical mapping associated with the Site, the following Site history can be deduced:

<table>
<thead>
<tr>
<th>Year</th>
<th>On-Site</th>
<th>Vicinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1896 CS Map</td>
<td>The Study Site consisted of residential housing and gardens.</td>
<td>The Site was situated in a densely developed urban area, predominantly consisting of residential housing.</td>
</tr>
<tr>
<td>1915 CS Map</td>
<td>A large structure was constructed in the centre of the Site.</td>
<td>The large on-site structure extended to the south-east of the Site.</td>
</tr>
<tr>
<td>1936 CS Map</td>
<td>Residential housing was demolished in the south-eastern sector of the Site and superseded but a larger structure.</td>
<td>Residential housing was demolished to the north-east of the Site and superseded but a larger structure.</td>
</tr>
<tr>
<td>1954 OS Map</td>
<td>The large central structure was labelled as a Milk Depot and <em>Kingsbury House</em> was labelled in the south-east of the Site. <em>Ward’s Flats</em> were labelled on the north-western boundary.</td>
<td>Several ‘ruins’ and missing buildings were identified in the vicinity.</td>
</tr>
<tr>
<td>1962 OS Map</td>
<td>A surgery was labelled in the northern sector of the Site and the Milk Depot was re-labelled as a Garage.</td>
<td>Buildings to the west of the Site were redeveloped.</td>
</tr>
<tr>
<td>1973 OS Map</td>
<td>All buildings within the Site were demolished and replaced with concrete hardstanding.</td>
<td><em>Parsons House</em> was labelled immediate to the south of the Site.</td>
</tr>
<tr>
<td>1985 OS Map</td>
<td>Changes were not recorded at the Study Site.</td>
<td>Changes were not recorded in the vicinity.</td>
</tr>
<tr>
<td>1991 OS Map</td>
<td>Changes were not recorded at the Study Site.</td>
<td>Changes were not recorded in the vicinity.</td>
</tr>
<tr>
<td>1999 OS Map</td>
<td>Changes were not recorded at the Study Site.</td>
<td>Changes were not recorded in the vicinity.</td>
</tr>
<tr>
<td>2017 OS Map</td>
<td>Changes were not recorded at the Study Site.</td>
<td>Changes were not recorded in the vicinity.</td>
</tr>
</tbody>
</table>

WWII Site Use
The CS mapping prior to WWII (1938), shows that the Study Site was located within a heavily developed urban area and consisted of residential housing and a milk depot.

Aerial Photography (1945) *(Figure 4)*
The aerial photography (1945) associated with the Site shows that it consisted of several small structures within a heavily developed area. That said, the resolution of the photograph is not sufficient enough to be able to accurately identify the features and/or structures within the Site at that time.

WWII Bombing of London
The most intensive period of bombing over *London* was the nine months between October 1940 and May 1941, known as ‘The Blitz’. During this period, the *Luftwaffe* attempted to overwhelm *Britain’s* air defences, destroy key military and industrial facilities, as well as logistical capabilities, prior to invasion.

A total of 18,000 tons of bombs were dropped on *London* between 1940 and 1945. Many residential, commercial and industrial buildings were targeted during air raids and sustained large scale damage. Public services were also affected, with gas, electricity and water supplies often cut-off following damage to either the installations themselves or to the supply infrastructure. In addition, thousands of civilians were killed and injured, and many were forced to evacuate as their homes were destroyed.
STAGE TWO – REVIEW OF HISTORICAL DATASETS (...continued)

WWII Luftwaffe Bombing Targets (Figure 5)

Prior to WWII, the Luftwaffe conducted numerous aerial photographic reconnaissance missions over Britain, recording key military, industrial and commercial facilities for attack, in the event of war. In addition, logistics infrastructure and public services, such as railways, canals, power stations, reservoirs, water and gas works were also considered viable bombing targets.

Luftwaffe aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m of it. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets.

WWII HE Bomb Strikes (Figure 6)

During WWII, ARP wardens compiled detailed logs of bomb strikes across their respective districts. ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; approximately 30m to the south-east, 50m to the south, 55m to the east-south-east, 75m to the north-north-east, 85m to the south-south-east, 85m to the north-east and 95m to the south-east. Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

In addition to IBs and HE bomb strikes, during the latter part of the war when aerial bombing had significantly declined, the main threat came from 'V' type weapons. These rockets were thin-skinned, unmanned and inaccurate weapons. ARP records identify a V1 rocket 360m to the north-east of the Site.

WWII Bomb Damage (Figure 7)

An analysis of the LCC bomb damage maps associated with the Site identifies “blast damage, minor in nature” and “general blast damage – not structural” to buildings located within the Site. In addition, “damage beyond repair” and “total destruction” were recorded to buildings located immediately to the south of the Site.

Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous “ruins” within the Site’s vicinity, which is likely to be attributed to bombing.

WWII HE Bomb Density (Figure 8)

The Study Site was located within the Paddington Metropolitan Borough and St. Marylebone Metropolitan Borough, which recorded 54 and 67 HE bombs per 100 hectares respectively, both very high levels of bombing

Abandoned Bombs

An examination of the official abandoned bomb records did not identify any abandoned bombs within 1,000m of the Study Site.

Records of WWII UXB Disposal Tasks

An examination of the civil defence records listing UXBs dealt within in the Paddington Metropolitan Borough from 1940-45 has identified the following tasks within the Site’s vicinity:

- One UXB was burnt in-situ from 14 Maida Vale (located approximately 125m to the north-west) on the 21st February 1944;
- One UXB was removed from 26 Warwick Avenue (located approximately 420m to the west) on the 21st February 1944;
- One UXB was removed from 12 Orsett Mews (situated 820m to the south-west) on the 17th March 1944;
- One UXB was removed from 212 Gloucester Terrace (located approximately 845m to the south-west) on the 23rd February 1944.
STAGE TWO – REVIEW OF HISTORICAL DATASETS (...continued)

Records of Post-WWII UXB Disposal Tasks

An examination of the post-WWII BDO tasks associated with the area has not identified any BDO operations within the Site itself, however the following tasks were undertaken in the area:

- The collection of one IB from *Paddington Green Police Station* (located 450m to the south-east) on the 27th January 1956;
- The collection of one IB from *Paddington Green Police Station* (located 450m to the south-east) on the 22nd January 1957.
## STAGE THREE – DATA ANALYSIS

### Was the ground undeveloped during WWII?

No; according to the CS mapping prior to WWII (1938), the Study Site consisted of residential housing and a milk depot and was situated in a heavily developed urban area.

### Is there a reason to suspect that the immediate area was a bombing target during WWII?

No; _Luftwaffe_ aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets. As WWII progressed, major towns and cities became targets within their own right as the _Luftwaffe_ switched from specifically targeting industrial and military facilities to a more general method of ‘carpet bombing’, and as a result, suburban and residential areas were frequently bombed.

### Is there firm evidence that ordnance landed on-site?

No; ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; approximately 30m to the south-east, 50m to the south, 55m to the east-south-east, 75m to the north-north-east, 85m to the south-south-east, 85m to the north-east and 95m to the south-east. In addition, a UXB disposal task was recorded 125m to the north-west of the Site.

Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

### Is there firm evidence of bomb damage on-site?

Yes; an analysis of the LCC maps associated with the Site shows “blast damage, minor in nature” and “general blast damage – not structural” to buildings within the Site. In addition, “damage beyond repair” and “total destruction” were recorded to buildings located immediately to the south of the Site.

Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous “ruins” and missing buildings within the Site’s vicinity, which is likely to be attributed to bombing.

### Would a UXB entry hole have been observed and reported during WWII?

Possibly; the Site did comprise residential housing and a milk depot during WWII and therefore, it is plausible that a local resident would have observed and reported any UXB entry hole following any raids. However, given the development of the Site and with the bomb damage recorded, it is possible that UXB entry holes may have been masked by debris resulting from subsequent bomb strikes, and therefore may have gone unnoticed.

### Is there any reason to suspect that live firing or military training may have occurred at this location?

No; there is no supporting evidence to suggest that military training, guns or associated artillery (or other types of) munitions were ever stored, manufactured, located and/or fired from this Site during WWII nor subsequently.

### What is the expected level of UXO contamination?

The most likely source of UXO contamination is from _German_ aerially delivered ordnance, which ranges from small IBs through to large HE bombs (the latter forms the principal threat). Additional residual contamination may be present from _British_ AAA projectiles (which were used to defend the UK against _German_ bombing raids).
Would previous earthwork have removed the potential for UXO to be present?

Probably; from an analysis of post-WWII mapping associated with the Site, the following phases of Site activity were evident:

**1954 OS Map** - The large central structure was labelled as a Milk Depot and *Kingsbury House* was labelled in the south-east of the Site. *Ward’s Flats* were labelled on the north-western boundary.

**1962 OS Map** - A surgery was labelled in the northern sector of the Site and the Milk Depot was re-labelled as a Garage.

**1973 OS Map** - All buildings within the Site were demolished and replaced with concrete hardstanding.

On this evidence, it is apparent that the Site has not been subjected to any significant post-war redevelopment until the early 1970s when the Site was cleared and a basement car park was constructed. As a result, it is highly likely that any UXO within the structural footprint of the basement car park would have been discovered and removed; however, the potential for deep buried UXO to be present below these foundations is assessed to remain remotely extant.

Does the probability of a UXO discovery vary across the Site?

Yes; the probability of discovering UXO has been largely mitigated within the footprints of the existing foundations. However, it is considered remotely possible that UXO may be present below the existing foundations and within previously undisturbed ground (see stage 4).
STAGE FOUR – RISK ASSESSMENT

Threat Items
The most probable UXO threat items are German HE bombs, whilst IBs and British AAA projectiles pose a residual threat. The consequences of initiating German HE bombs are more severe than initiating IBs or AAA projectiles, and thus they pose the greatest prospective risk to intrusive works.

Maximum Bomb Penetration Depth
Considering the ground conditions (highlighted in Stage 1), the average BPD for a 250kg German HE bomb within clays is assessed to be approximately 7m bgl, with the maximum BPD considered to be approximately 16m bgl. Although it is possible that the Luftwaffe deployed larger bombs in the area, their deployment was infrequent, and to use such larger (or the largest) bombs for BPD calculations are not justifiable on either technical or risk management grounds. WWII German bombs have a greater penetration depth when compared to IBs and AAA projectiles, which are unlikely to be encountered at depths greater than 1m bgl. Given the development of the Site during WWII, the BPDs may vary from those stated above as structures may have reduced the penetration into the ground.

Risk Pathway
Given the types of UXO that might be present on Site, all types of aggressive intrusive engineering activities (i.e. excavations and piling) may generate a significant risk pathway. Whilst not all UXO encountered aggressively will initiate upon contact, such a discovery could lead to serious impact on the project especially in terms of critical injury to personnel, damage to equipment and project delay.

Prospective Consequences
Consequences of UXO initiation include:
1. Fatally injure personnel;
2. Severe damage to plant and equipment;
3. Deliver blast and fragmentation damage to nearby buildings;
4. Rupture and damage underground utilities/services.

Consequences of UXO discovery include:
1. Delay to the project and blight;
2. Disruption to local community/infrastructure;
3. The expenditure of additional risk mitigation resources and EOD clearance;
4. Incurring additional time and cost.

UXO RISK CALCULATION
Site Activities
Although there is some variation in the probability of encountering and initiating items of UXO when conducting different types of intrusive activities, a number of construction methodologies have been described for analysis at this Site. The consequences of initiating UXO vary greatly, depending upon, inter alia the mass of HE in the UXO and how aggressively it might be encountered. For this reason, 6 Alpha has conducted separate risk rating calculations for each construction methodology that might be employed.

Risk Rating Calculation
6 Alpha’s Semi-Quantitative Risk Assessment assesses and rates the risks posed by the most probable threat items when conducting a number of different activities on the Site. Risk Rating is determined by calculating the probability of encountering UXO and the consequences of initiating it.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Threat Item</th>
<th>Probability ((SH \times EM = P))</th>
<th>Consequence ((D \times PSR = C))</th>
<th>Risk Rating ((P \times C = RR))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavations (Within Existing Foundations)</td>
<td>HE Bombs</td>
<td>1x3=3</td>
<td>3x2=6</td>
<td>3x6=18</td>
</tr>
<tr>
<td></td>
<td>AAA Projectiles</td>
<td>1x3=3</td>
<td>3x1=3</td>
<td>3x3=9</td>
</tr>
<tr>
<td></td>
<td>IBs</td>
<td>1x3=3</td>
<td>3x1=3</td>
<td>3x3=9</td>
</tr>
<tr>
<td>Piling (Within Existing Foundations)</td>
<td>HE Bombs</td>
<td>1x2=2</td>
<td>3x3=9</td>
<td>2x9=18</td>
</tr>
<tr>
<td></td>
<td>AAA Projectiles</td>
<td>1x2=2</td>
<td>3x1=3</td>
<td>3x3=9</td>
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<td>3x1=3</td>
<td>3x3=9</td>
</tr>
</tbody>
</table>

Abbreviations – Site History (SH), Engineering Methodology (EM), Probability (P), Depth (D), Consequence (C), Proximity to Sensitive Receptors (PSR) and Risk Rating (RR).
STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES

If a geophysical survey is required are the ground conditions an issue?

Non-Intrusive Methods of Mitigation – Magnetometer results will be affected by the concrete basement car park, in which case the Site would need to be excavated and cleared for non-intrusive methods of mitigation to be effective on this Site.

Intrusive Methods of Mitigation – The Site would also need to be cleared in order for intrusive magnetometry to be effective on this Site, as the concrete basement would create a ‘hardstop’ for CPT technology. Beyond the basement such a survey should prove effective prior to piling especially.

MITIGATION MEASURES TO REDUCE RISK TO ‘ALARP’

<table>
<thead>
<tr>
<th>Activity/Area</th>
<th>Risk Mitigation Measures</th>
<th>Final Risk Rating</th>
</tr>
</thead>
</table>
| All Activities in All Areas | **1. Operational UXO Emergency Response Plan;** appropriate Site Management documentation should be held on Site to guide and plan for the actions which should be undertaken in the event of a suspected or confirmed UXO discovery (this plan can be supplied by 6 Alpha);  
**2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of an-UXO / UXB encounter and are a vital part of the general safety requirement. All personnel working on the Site should receive a briefing on the identification of an UXO / UXB, what actions they should take to keep people and equipment away from such a hazard and to alert Site management. Information concerning the nature of the UXO / UXB threat should be held in the Site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The Safety & Awareness briefing is an essential part of the Health & Safety Plan for the Site and helps to evidence conformity with the principles laid down in the CDM regulations 2015 (this briefing can be delivered directly, or in some cases remotely, by 6 Alpha). | ALARP |

This assessment has been conducted based on the information provided by the Client, should the proposed works change then 6 Alpha should be re-engaged to refine this risk assessment.
Report Figures
Figure One

Site Location
Figure Two

Site Boundary
Figure Three

Aerial Photography (Current)
Figure Four

Aerial Photography (1945)
Figure Five

WWII Luftwaffe Bombing Targets
Figure Six

WWII High Explosive Bomb Strikes
Figure Seven

London County Council WWII Bomb Damage Map
Figure Eight

WWII High Explosive Bomb Density