Explosive Ordnance Threat Assessment for Future Works

Site: **MoD Beach & Park Garrison Site, Shoeburyness**

Client: **Southend-on-Sea Borough Council**

Ref: **6180TA Rev-3**

Date: **27th November 2015**

Dynasafe BACTEC Limited
9, Waterside Court, Galleon Boulevard, Crossways Business Park, Dartford, Kent, DA2 6NX, UK
Office: +44 (0) 1322 284 550 **www.bactec.com**

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This Report has been produced in compliance with the Construction Industry Research and Information Association guidelines for the preparation of Detailed Risk Assessments in the management of UXO risks in the construction industry.

Glossary of Terms

AAA	Anti-Aircraft Artillery
ARP	Air-raid Precautions
BDO	Bomb Disposal Officer
EOD	Explosive Ordnance Disposal (current term for “bomb” disposal)
HE	High Explosive
HG	Home Guard
IB	Incendiary Bomb
kg	Kilogram
LCC	London County Council
LM	Land Mine
LSA	Land Service Ammunition (includes grenades, mortars, etc.)
Luftwaffe	German Air Force
m bgl	Metres Below Ground Level
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
RAF	Royal Air Force
SI	Site Investigation
SAA	Small Arms Ammunition (small calibre cartridges used in rifles & machine guns)
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	“Doodlebug” the first cruise type missile, used against London from June 1944. Also known as ‘Flying Bomb’.
V-2	The first ballistic missile, used against London from September 1944
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

Executive Summary

The Site: The site, centred on the approximate OS Grid Reference: 593451, 184472, is located in between the towns of Shoeburyness and Thorpe Bay on the south-east Essex coast. It is bound to the west by Ness Road, to the north by Campfield Road / Chapel Road / The Terraces (road) and to the south by the sea.

The site occupies a large portion of Shoeburyness Old Ranges, a disused former Army training facility within the wider MoD Shoeburyness Ranges Area; currently operated by Quinetiq. The majority of the study area is occupied by Gunners Park and some additional areas of open ground to the east. The site also incorporates the entire foreshore / beach zone stretching from Shoebury East Beach (in the north-east) to just beyond the Coastguard Station (in the south-west).

Proposed Works: Within the park works area, a variety of future projects (mainly landscaping) are proposed with associated intrusions down to a maximum depth of 1m bgl. Within the seawall, groynes and foreshore area, more significant maintenance works are planned. These could involve repair to the foot of the seawall, groyne pile and groyne board maintenance / replacement, as well as redistribution of foreshore material that builds up against the groynes.

Risk Assessment Methodology: In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the risks that the site has been contaminated with unexploded ordnance; that such items remained on site; that they could be encountered during the proposed works and the consequences that could result. Appropriate risk mitigation measures have been proposed.

Explosive Ordnance Risk Assessment: Dynasafe BACTEC concludes that the site includes zones of ***HIGH RISK***, ***LOW-MEDIUM RISK*** and ***LOW RISK*** from unexploded ordnance (UXO). This is based on the following factors:

British UXO

- The site is occupied by a former MoD live small arms and artillery range (The Old Ranges), dating back to the 19th Century. Note however, clusters of HE blast craters on WWII-era aerial photography suggest that parts of the range have also been used historically for either demolitions (EOD) training or infantry training with grenades, mortars, etc.
- The 'housekeeping' at military ranges is known to have been poor during the 19th and 20th centuries with faulty, surplus or expended items of UXO often left in situ, burnt, buried or misplaced on site, resulting in legacy of UXO contamination up to the present day. This is substantiated by numerous UXO finds made by both Army and Dynasafe BACTEC EOD Engineers within the study area.
- During the 19th Century (in particular) seaward artillery firing within the Old Ranges would have resulted in numerous live HE and inert shot projectiles landing on Maplin Sands. Since then the beaches within the study area have been contaminated with this UXO, as it continues to be washed ashore.
- Historical OS mapping records two neighbouring earth-bunded buildings on site, used for the storage of large quantities of ammunition. In addition, a Heavy Anti-Aircraft (HAA) battery was constructed on site in the late 1930s and several coastal batteries have persisted since the 19th Century. Therefore significant quantities of HE projectiles would have been stored within magazines at these localities. Previous experience at similar sites suggests faulty shells were occasionally discarded in the immediate surrounding area, subsequently becoming buried.
- As a coastal site within a vulnerable location (relatively close to occupied Europe) the beaches on were fortified with coastal gun batteries and anti-tank defences during 1940, when the threat of German invasion was high. Regular Army and Home Guard troops would have stationed locally and will likely have carried out live fire beach defence exercises, which could have resulted in UXO contamination on site.
- Home Guard troops in particular are known to have buried caches of grenades, ammunition, etc in strategic locations, close to likely invasion beaches and therefore the possibility that such activities occurred within the site boundary cannot be discounted.
- Three HAA batteries were positioned within a 3km radius of the site during WWII. Furthermore, anecdotal accounts suggest that during 1944 several additional batteries were installed on the Shoeburyness islands to counter the V1 Flying Bomb threat. The undeveloped nature of the site coupled with increased Luftwaffe activity in the area during WWII suggests there is an elevated risk of expended yet unexploded AA shell contamination.
- Note it is highly unlikely that any ammunition would have been handled / utilised on the cricket pitch, which has been present since the establishment of the Old Ranges. Similarly an adjacent section of recreational land (including some tennis courts) appears to be separated from the weapons ranges / beach area, suggesting UXO contamination is less likely here.

German UXO

- Positioned relatively close to London, as well as at the mouth of the Thames Estuary Luftwaffe flight path, Shoeburyness was positioned close to any area of increased aerial activity during 1940 and 1941. A 1939 German aerial target photograph earmarks three coastal batteries within the site, for destruction. Consequently several small scale and one medium scale air raids occurred in the local area. The Old Ranges therefore occupied an area of moderate bombing density.

- A German bomb census map of the area records one HE bomb, anti-personnel bomb or AA shell bomb strike on site as well as a further four at its eastern, north-eastern and western boundaries. An unexploded high explosive bomb, anti-personnel bomb or AA shell is also plotted just within the eastern end of the study area.
- A large portion of the study area comprised isolated open ground during WWII and therefore will not have been accessed as frequently / regularly as the developed barracks area. Indeed some peripheral localities may have been neglected entirely. Consequently it is considered possible that a UXB could have fallen unnoticed on site, especially since many air raids in the wider area occurred at night.
- Furthermore, had such an incident occurred, the resulting evidence may have remained undetected in the unmaintained grass fields, saltings, sandy beaches / shingle that occupied much of the site. Note that the entry hole of an SC50 UXB (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter and therefore easily obscured in such ground cover.

An extensive EOD task carried out by the Army within the Old Ranges during 1982, will have mitigated much of the risk from UXO on site, however subsequent EOD tasks carried out by Dynasafe BACTEC within the Old Ranges suggest this was not a comprehensive clearance, as additional UXO was encountered. Furthermore the site has remained undeveloped and therefore there has been no risk mitigation from construction and associated earth works within the MoD Beach & Park Garrison study area.

There is also evidence that tidal currents and wave action have resulted in additional items of UXO being washed up on the study area beaches. Furthermore, it is possible (especially during storm conditions) that such items could then become shallow buried in beach sediments / shingle.

Bomb Penetration Assessment: It has been assessed that a 500kg bomb would have had a maximum bomb penetration depth of up to **8m** below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth. This assessment has been made using generic geological information.

Risk Mitigation Measures: The MoD Beach & Park Garrison site is large and complex with a likely high concentration of UXO contamination in some parts and therefore it is recommended that a meeting be held between senior Dynasafe BACTEC EOD personnel and Southend-on-Sea Borough Council to discuss the best options for mitigating the UXO risk during future maintenance works.

It is understood that the proposal requires the section of beach and foreshore within the study area to be reopened to the public. Dynasafe BACTEC's previous experience clearing UXO in this locality would be invaluable in forming a cost effective Risk Mitigation Strategy. Such a strategy is likely to involve a combination of the following mitigation measures, where deemed necessary and appropriate:

All Risk Zones:

- *Explosive Ordnance Safety and Awareness Briefings to any personnel conducting intrusive works*
- *The provision of Unexploded Ordnance Site Safety Instructions*

Low-Medium and High Risk Zones only:

- *Explosive Ordnance Disposal (EOD) Engineer presence on site to supervise any future open excavations*
- *Explosive Ordnance Sifter Deployed to Clear Beach Sediments*

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

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Annexes

Explosive Ordnance Threat Assessment for Future Works

In Relation To

The MoD Beach & Park Garrison Site, Shoeburyness

1. Introduction

1.1. Background

Southend-on-Sea Borough Council has commissioned Dynsafe BACTEC Limited to conduct an Explosive Ordnance Threat Assessment for the Proposed Works (i.e. potential future works as outlined in *Section 6*) at the MoD Beach & Park Garrison site, Shoeburyness.

Unexploded Ordnance presents a significant threat to construction projects in parts of the UK as a result of enemy actions during the two 20th Century World Wars and historic British and Allied military activity.

MoD Shoeburyness was established in 1849 and since then has grown considerably to become the UK's largest land range. During this time ammunition has been expended in the order of several million items and numerous different types of weapon have been tested, from all periods of modern warfare. The range is currently operated privately by Qinetiq and is mostly concerned with large calibre weapons testing, static trials and environmental testing of munitions.

In addition, one of the legacies of the two World Wars is buried unexploded air-dropped bombs or anti-aircraft projectiles resulting from the failure of a proportion of such weapons to function as designed. It is commonly accepted that the failure rate of these munitions was approximately 10% and, depending on their shape, weight, velocity and ground conditions many penetrated the ground and came to rest at depth.

Intensive efforts were made during and after the war to locate and render safe all UXO but, unsurprisingly, not all were found and dealt with. This is evidenced by the regular, on-going discoveries of unexploded ordnance during construction-related intrusive ground works.

As a result of a generally increased risk awareness amongst professionals involved in ground engineering works and proactive health and safety measures, the threat to life and limb from unexploded ordnance has been minimised. However even the simple discovery of a suspected device during ongoing works can cause considerable disruption to production and cause unwanted delays and expense.

Such risks can be more fully controlled by a better understanding of the site-specific threat and the implementation of appropriate risk mitigation measures.

2. Construction Industry Duties and Responsibilities

2.1. The UK Regulatory Environment

There is no specific legislation covering the management and control of the UXO risk in the UK construction industry but issues regarding health and safety are addressed under a number of regulatory instruments, as outlined below.

In practice the regulations impose a responsibility on the construction industry to ensure that they discharge their obligations to protect those engaged in ground-intrusive operations (such as archaeology, site investigation, drilling, piling or excavations) from any reasonably foreseeable UXO risk.

2.2. The Health and Safety at Work Act, 1974

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

2.3. Construction (Design and Management) Regulations 2015

This legislation defines the responsibilities of all parties (primarily the Client, the CDM Co-ordinator, the Designer and the Principal Contractor) involved with works.

Although UXO issues are not specifically addressed the regulations effectively place obligations on all these parties to:

- Ensure that any potential UXO risk is properly assessed
- Put in place appropriate risk mitigation measures if necessary
- Keep all parties affected by the risk fully informed
- Prepare a suitably robust emergency response plan

2.4. Other Legislation

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

3. The Role of the Authorities and Commercial Contractors

3.1. The Authorities

The Police have the responsibilities for co-ordinating the emergency services in the case of an ordnance-related incident on a construction site. They will make an initial assessment (i.e. is there a risk that the find is ordnance or not?) and if they judge necessary impose a safety cordon and/or evacuation and call the military authorities (JSEOD - Joint Services Explosive Ordnance Disposal Operations centre) to arrange for investigation and/or disposal. In the absence of an EOD specialist on site many Police Officers will use the precautionary principle, impose cordon(s)/evacuation and await advice from the JSEOD.

The priority given to the request by JSEOD will depend on their judgement of the nature of the threat (ordnance, location, people and assets at risk) and the availability of resources. They may respond immediately or as resources are freed up. Depending on the on-site risk assessment the item of ordnance may be removed or demolished (by controlled explosion) in-situ. In the latter case additional cordons and/or evacuations may be necessary.

Note that the military authorities will only carry out further investigations or clearances in very high profile or high risk situations. If there are regular ordnance finds on a site the JSEOD may not treat each occurrence as an emergency and will encourage the construction company to put in place alternative procedures (i.e. the appointment of a commercial contractor) to manage the situation and relieve pressure from the JSEOD disposal teams.

3.2. Commercial Contractors

In addition to pre-construction site surveys and clearances a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary call-outs to the authorities and the Contractor will be able to arrange for the removal and disposal of low risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

4. This Report

4.1. Aims and Objectives

The aim of this report is to examine the possibility of encountering any explosive ordnance during the proposed works at the MoD Beach & Park Garrison site. Risk mitigation measures will be recommended, if deemed necessary, to reduce the threat from explosive ordnance during the envisaged works. The report follows the CIRIA Guidelines.

4.2. Risk Assessment Methodology

The following issues will be addressed in the report:

- The risk that the site was contaminated with unexploded ordnance.
- The risk that unexploded ordnance remains on site.
- The risk that ordnance may be encountered during the proposed works.
- The risk that ordnance may be initiated.
- The consequences of initiating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended if required.

4.3. Approach

In preparing this Explosive Ordnance Threat Assessment Report, Dynasafe BACTEC has considered general and, as far as possible, site specific factors including:

- Evidence of German bombing and delivery of UXBs.
- Site history, occupancy and conditions during WWII.
- The legacy of Allied military activity.
- Details of any known EOD clearance activity.
- The extent of any post war redevelopment.
- Scope of the current proposed works.

4.4. Sources of Information

Dynasafe BACTEC has carried out detailed historical research for this Explosive Ordnance Threat Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from the following sources has been consulted:

- The National Archives.
- Essex Record Office.
- Foulness Heritage Centre.
- The Ministry of Defence - Defence Estates.
- British Army 33 Engineer Regiment (EOD) Archive.
- The Council for British Archaeology.
- F!ND Maps.
- Historic England.
- Relevant information supplied by Southend-on-Sea Borough Council.
- Dynasafe BACTEC's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

4.5. Reliability of Historical Records

4.5.1. General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material Dynasafe BACTEC cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result conclusions as to the exact location, quantity and nature of the ordnance threat can never be definitive but must be based on the accumulation and careful analysis of all accessible evidence. Dynasafe BACTEC cannot be held responsible for inaccuracies or gaps in the available historical information.

4.5.2. Bombing Records

During WWII considerable efforts were expended in recording enemy air raids. Air Raid Precautions (ARP) wardens were responsible for making records of bomb strikes either through direct observation or by post-raid surveys. However their immediate priority was to deal with casualties and limit damage, so it is to be expected that records are often incomplete and sometimes contradictory. Record keeping in the early days of bombing was not comprehensive and details of bombing in the early part of the war were sometimes destroyed in subsequent attacks. Some reports may cover a single attack, others a period of months or the entire war.

Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are not always reliable; records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

5. The Site

5.1. Site Location

The site is located in between the towns of Shoeburyness and Thorpe Bay on the south-east Essex coast. It is bound to the west by Ness Road, to the north by Campfield Road / Chapel Road / The Terraces (road) and to the south by the sea.

The site is centred on the approximate OS Grid Reference: 593451, 184472

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

5.2. Site Description

The site occupies a large portion of Shoeburyness Old Ranges, a disused former Army training facility within the wider MoD Shoeburyness Ranges Area; currently operated by Quinetiq. The majority of the study area is occupied by Gunners Park and some additional areas of open ground to the east. The site also incorporates the entire foreshore / beach zone stretching from Shoebury East Beach (in the north-east) to just beyond the Coastguard Station (in the south-west).

A Recent Aerial Photograph of the site is presented in ***Annex B.***

6. Scope of the Proposed Works

A range of future projects, requiring intrusive ground work, has been identified within the Park works area and the Seawall, Groynes and Foreshore works area. These are listed below. A Site Plan showing the extent of the study area is presented in ***Annex C***.

6.1. Park Works Area

- Tree planting. Excavation depth between 300mm to 1,000mm
- Shrub Planting. Excavation depth between 150mm to 300mm
- Installation of signage. Excavation depth between 300mm to 500m
- Replacement of play equipment. Excavation depth between 150mm to 750mm
- Path installation. Excavation depth between 100mm to 300mm
- Installation of fencing. Excavation depth between 200mm to 500mm

6.2. Seawall, Groynes and Foreshore Works Area

- Breach of the seawall requiring major civil engineering works, including digging into the foreshore to repair the foot of the seawall.
- Driving new piles for groynes or having to dig down around piles to cut off tops and replace them. Excavation to approximately 1m bgl.
- Digging down to replace boards on the groynes.
- Redistribution of foreshore material that builds up against the groynes.

7. Ground Conditions

Published BGS data for a borehole sunk at the very western extent of the site in March 1991 records the following shallow geological sequence in the vicinity:

- 5m of loose to medium dense silty SAND
- 1m of loose silty SAND with gravel
- 3m of stiff silty CLAY
- >5m of very stiff laminated silty CLAY

8. Site History

8.1. General

8.1.1. 19th Century

In the 1840s the need arose for a new artillery range in Britain. In 1849 a small site at the south-east corner of Shoeburyness town was chosen and soon a group of sappers and miners began constructing the first Shoeburyness battery. In 1859 the first British School of Gunnery was established here and so a major building program commenced and by the mid-1860s the majority of the barrack buildings as they are seen today were completed. Weapons testing during the first forty years of the range was primarily concerned with land/naval artillery and was confined to a relatively small area known as the Old Ranges (the study area).

Artillery training, experimental use of guns, rockets and explosives, and the testing of armour and defensive casements at the Old Ranges grew up to the end of the century.

By the mid-1880s, advances in artillery technology necessitated a considerable increase in the size of the Shoeburyness Ranges. Consequently, land to the north-east known as the New Ranges, was purchased in 1889 and was rapidly developed into the 'experimental and testing facility', with the Old Ranges concentrating on training. Eventually the New Ranges would stretch >10km kilometres north-east along the Essex coast, to its present day extent, the northern tip of Foulness Island.

Whilst the New Ranges became responsible for the vast majority of artillery testing / proofing, the construction of the Heavy Quick Firing (HQF) battery in 1900 within the Old Ranges, coupled with the presence of a 600 yard rifle range, confirms the continuation of live firing within the study area.

8.1.2. World War I

The onset of WWI witnessed an increased military presence on the Old Ranges, with various Infantry Units occupying the barracks throughout the period. Additionally, the first Anti-Aircraft School of Instruction, established on the New Ranges in 1915, saw the establishment of six new mobile Anti-Aircraft (AA) guns within the Old Ranges.

8.1.3. Interwar

Following the end of the war, the scaling back of the Army started a relative period of quiet at the Old Ranges. As the majority of Artillery was relocated to the new School of Artillery in

Larkhill and the AA school moved to Perham Down, both in 1920, it left only a small element formed as the 'Coast Artillery School'.

Comprised of two Medium Artillery Brigades, the Coast Artillery School was responsible for simulating long range coastal defence training, operating from the original HQF battery site and the Seawall battery constructed in 1909, throughout the interwar period.

Rearmament in 1936 led to new defences including air raid shelters, command posts, new batteries, and searchlight emplacements being constructed in the Old Ranges.

8.1.4. World War II

Once again, the onset of major conflict (WWII) resulted in a period of increased activity at the Shoebury Old Ranges. While the Coastal Artillery School was moved to Llandudno in September 1940, the formation of 22 Heavy and Medium Training Regiment, later 22 Royal Artillery Training Regiment (Anti–Tank), saw a return to onshore practice firing, throughout WWII. In addition, a number of smaller units were to visit the Old Ranges during the war, to carryout gunnery practice.

Additionally, the arrival of 5 Battery Maritime Royal Artillery in 1942, and the presence of various heavy AA and light AA elements, manned predominantly by Home Guard units, substantiated the importance of the Old Ranges.

8.1.5. Post War

The cessation of the war in 1945 once again saw a decrease in activity at the Old Ranges. Both 22 Royal Artillery Training Regiment and 5 Battery Maritime Royal Artillery were disbanded in 1945.

Shoebury Garrison continued to house residential artillery units until 1976, when the Garrison HQ closed, leaving only a small Military Wing of senior personnel, finally leaving the Old Ranges in 1997. The remaining site was sold in 2000 and developed into 'The Garrison housing development', whilst the Old Rifle Range was identified to 'be improved for public use'.

8.2. Historical Mapping

A collection of historical maps for the area was reviewed. Sections of these are presented in ***Annex D*** and described below.

8.2.1. 1874

This pre-WWI map shows the site to be mainly undeveloped, however buildings associated with the *Artillery Barracks* are present on site. A solitary *Butt* is labelled within the study area, suggesting live firing of some type. In addition, a gun *Battery* is also marked along the coastal section of the site. Note also the presence of sports pitches on site, including a *Cricket Ground* and *Croquet Ground.*

8.2.2. 1897

This 1:2,500 scale OS map shows the site in more detail. Some tramways have been laid in open ground, presumably necessary for transporting large artillery pieces around the training area. A long *Rifle Range* is apparent within the western half of Gunners Park and a row of *Hut Barracks* is labelled to the north-east, fronting the beach. As well as sports pitches, the study area is littered with unidentified buildings, likely relating to military training.

Note two *Boat Houses*, a *Landing Slip* and *P*ier are present along the north-eastern section of beach.

8.2.3. 1939

The immediately pre-WWII 1:2,500 scale OS map shows some changes on site. A new gunnery range with butts at different distances (adjacent to the aforementioned rifle range) is plotted. Two neighbouring ammunition storage buildings have been constructed on site;

identifiable by their earth embankments (bunds), built to reduce the effect of blast during any accidental detonation of munitions.

The Artillery Barracks has been renamed Danish Encampment and has undergone significant redevelopment / additional development within the north-east portion of the study area.

8.3. Historical RAF Aerial Photography

RAF aerial photography of the study area was obtained. Several images (mainly of WWII-era) are presented in ***Annex E*** and described below.

8.3.1. August 1947

Several images dated August 1947 show the site in the immediate post-WWII period. A large section of the back beach zone is occupied by rows of anti-tank pimples (Dragon's Teeth). These would have been installed during 1940, when the threat from German invasion was high.

The casemates of several coastal gun batteries (some of which are still present today) are identifiable along the beach. However there are also sections of beach (further north-east) which have a more residential appearance, being fronted by barrack huts and other dwellings.

Note the pot-marked appearance of some the open ground within Gunners Park. This suggests high explosive blast, either from British or German ordnance.

8.3.2. February 1948

This photograph shows two more areas containing numerous HE blast craters of varying size, further north from the coast. The concentration of these suggests they are not the result of German bombing, but from British training with live munitions. Note, only the southern highlighted area is within the site boundary.

Also noteworthy is that within this latter location a zig-zag trench line is identifiable. This was likely dug to help simulate battle conditions for infantry training. Just to the west of this, the remnants of a WWII four x gun heavy AA battery are apparent.

8.3.3. April 1951

This photograph shows the entire Old Ranges area and therefore is of small scale / low resolution. It does however exhibit more cratering at the south-western extent of the site. It should also be noted that no seriously damaged or destroyed buildings are identifiable on site.

The eastern extent of the site, adjacent to the barracks and to the rear of the cricket pitch appears to be an area of grass lawns, mature trees and tennis courts. This section of open ground seems to be separated from the actual weapons ranges.

9. The Threat from British Unexploded Ordnance

9.1. Potential Sources of Contamination

BACTEC has identified evidence of domestic military related activity on site, which could have led to UXO contamination.

The following historical and modern facilities / activities / incidents have been considered:

- Army, Navy and RAF Bases / Installations
- Military Training Areas / Weapons Ranges
- Ordnance / Explosives Factories and Storage Depots
- Sites requisitioned for military use
- Military Fortifications and Coastal Defences
- Locations of Army Explosive Ordnance Clearance Tasks

- WWII Anti-Aircraft Batteries
- WWII Pipe Mined Locations and Beach Minefields

The following is a list of the potential sources / activities that could have led to localised UXO contamination.

9.2. Ammunition Storage and Disposal

The OS mapping records earth-bunded buildings on site, likely used for the storage of ammunition, for weapons training. In addition, a Heavy Anti-Aircraft (HAA) battery was constructed on site in the late 1930s. Therefore large quantities of 3.7" or 4.5" HAA projectiles would have been stored in a magazine, immediately to the rear of the four gun emplacements.

Previous Dynasafe BACTEC experience has shown that the risk of UXO contamination is higher within the footprint of munitions storage buildings and within their environs.

At military facilities where ammunition was stored and used, a designated burning pit was often sited in a peripheral, unused location. These areas would have been used for destroying any faulty or partially expended munitions and therefore had such activity occurred at the Old Ranges it will likely have resulted in contamination from partially burned items of UXO as well as explosives residue.

Note that Dynasafe BACTEC recently encountered such a pit within the historic perimeter of RAF Moreton-in-Marsh; a WWII-era Bomber Command airfield where ammunition was stored and used.

9.3. Live Fire Ranges

Since the 19th Century small arms ranges have occupied the site. Potential contamination associated with such facilities includes live rounds (bullets of various calibre) and heavy metals such as Lead, Antimony and Barium.

The risk associated with small arms ammunition is relatively low due to the fact that such ammunition is solid shot and does not contain any significant explosive fill. Although tracer round do have a small incendiary element that burns during flight.

However, historically, ranges were not always used for one type of weapons training. Particularly during periods of conflict, when training facilities were in much greater demand, it is likely that other sections of the MoD Beach & Park Garrison site were also used for training with other weapons such as grenades, mortars, rockets, etc.

Army ranges (close to urban areas) were also used by EOD personnel during WWII to safely dispose of any German UXBs that had been recovered from nearby towns and cities. These engineers may also have temporarily used the Old Ranges for training, which would have resulted in detonating many explosive items. This possibility is substantiated by the clusters of HE blast craters noted on WWII-era aerial photography.

Indeed it is known that field artillery units were based at the Old Ranges during WWII and therefore the ranges on site may have been adapted for small calibre field Howitzers, or larger calibre guns may have used the offshore area to fire into.

It is known that up until relatively recently (~1990s), health and safety policy at military facilities has not been as stringent as it is today. Munitions expended on land, whether they functioned as designed or not, are likely to have been abandoned rather than recovered, therefore increasing the likelihood that items of UXO still remain in-situ today

This is also substantiated by the fact that Dynasafe BACTEC has been involved with UXO clearance on site in the past and this has resulted in the recovery of a wide variety of Army projectiles.

In particular ponds and lakes, once drained, were found to be heavily contaminated with numerous items of UXO. It appears that ponds were used for dumping of munitions.

It should also be noted that historical Byelaws for the Old Ranges (the map of which is presented in ***Annex F***), confirm that the Danger Area extends out into sea. Therefore it is likely that during the 19th and 20th Centuries, training with larger calibre guns occurred along the coastal section of the site.

9.4. Home Guard Activity / Coastal Defences

The Home Guard (HG) was a defence organisation of the British Army, operational between 1940 and 1944. It comprised 1.5 million local volunteers, otherwise ineligible for military service, and acted as a secondary defence force, in case of enemy invasion. The HG guarded the southern and eastern coastal areas of Britain (such as the site), and other important facilities such as military bases, important factories and ordnance depots.

Records indicate that the two HG Battalions, the 16th Essex (Southend-on-Sea) and the 196th Rocket AA Battery were based nearby. It is also known that AA HG personnel were based at the Old Ranges for the latter part of WWII.

During 1940 when the threat from invasion was very high, a combination of HG and Army infantry personnel are likely to have made preparations on site. Anti-tank pimples were installed on the back beach area and these would have been accompanied by barbed wire, machine gun nests, booby traps and strategically placed weapons pits.

The latter were hand dug ditches used for cover if under fire and also doubled up as weapons / ammunition caches. Strategically placed boxes of grenades, mortars and small arms ammunition were buried by HG personnel near the coast in case of invasion. Comprehensive records of these do not exist and therefore forgotten caches have been encountered and exhumed in the post-war period, see ***Annex G***.

In addition, information taken from the Council for British Archaeology's study of the WWII anti-invasion landscape of England, (mapping the locations and types of existing defences around the country) records several costal gun batteries on site.

9.5. Anti-Aircraft Defences

9.5.1. Gun Batteries

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA), using large calibre weapons such as the 3.7" QF (Quick Firing) gun and Light Anti-Aircraft Artillery (LAA) using smaller calibre weapons such as 40mm Bofors gun.

During the early war period there was a severe shortage of AAA available and older WWI 3" and modified naval 4.5" guns were deployed alongside those available 3.7" weapons. The maximum ceiling height of fire at that time was around 11,000m (for the 3.7" gun and less for other weapons). As the war progressed improved variants of the 3.7" gun were introduced and, from 1942, large 5.25 inch weapons began to be brought into service. These had significantly improved ceiling heights of fire reaching over 18,000m.

The LAA batteries were intended to engage fast low flying aircraft and were typically deployed around airfields or strategic installations. These batteries were mobile and could be moved to new positions with relative ease when required. The most numerous of these was the 40mm Bofors gun which could fire up to 120 x 40mm HE shells per minute to over 1800m.

The HAA projectiles were high explosive shells, usually fitted with a time delay or barometric pressure fuze to make them explode at a pre-determined height. If they failed to explode or strike an aircraft, they would eventually fall back to earth. In January 1944 more people in London were killed by faulty HAA shells than by German bombs.

Although the larger unexploded projectiles could enter the ground they did not have great penetration ability and are therefore likely to be found close to WWII ground level. Numerous unexploded AAA shells were recovered during and following WWII and are still occasionally encountered on sites today. Historically, four HAA batteries were located within 5km of the site.

Three HAA batteries were positioned within a 3km radius of the site during WWII. Furthermore, anecdotal accounts suggest that during 1944 several additional batteries were installed on the Shoeburyness islands (to the north-east) to counter the V1 Flying Bomb threat.

With four guns per battery each firing at least 10 projectiles per minute, HAA batteries could expel numerous shells in even the shortest engagements. Unexploded HAA projectiles could land several kilometres from their batteries and therefore, due to the undeveloped nature of the site, there is considered to be an elevated risk of expended, yet unexploded, AA shell contamination.

9.5.1.1. Anti-Aircraft Rockets – 'Z' Batteries

Initially developed as a naval AA defensive weapon these were deployed at sites around the UK from 1941 and proved to be an effective addition to AA defences. They comprised groups of multiple rocket launchers, laid out in a grid formation, which could project a 2 or 3 Inch HE rocket, known as an Unrotating Projectile (UP), to an altitude of 6,000m and an effective ground range of over 9,000m.

The rocket body from an unexploded missile would not have survived impact with the ground but the warhead could have survived and penetrated below ground level in soft ground.

10. The Threat Posed by British Unexploded Ordnance

10.1. Small Arms Ammunition (SAA)

The most likely type of ordnance to be encountered on site are items of SAA (bullets), especially .303" ammunition which was the standard British and Commonwealth military cartridge from 1889 until the 1950s and the 7.62×51mm NATO standard round which replaced it.

Even if an item such as this functioned however, the explosion would not be contained within a barrel and detonation would only result in local overpressure and very minor fragmentation from the cartridge case.

Some LAA guns and RAF fighter cannons in use with British forces during WWII utilised the 20mm round. These bullets had a small fuse and a ~4 gram high explosive or incendiary charge. Although small, this fill quantity still has the potential to cause serious injury. Images of SAA are presented in ***Annex H***.

10.2. Land Service Ammunition (LSA)

10.2.1. General

The term Land Service Ammunition covers all items of ordnance that are propelled, placed or thrown during land warfare. They may be filled or charged with explosives, smoke, incendiary or pyrotechnics. They can be broken into five main groups:

a. Mortars
b. Grenades
c. Projectiles
d. Rockets
e. Landmines

Unexploded or partially unexploded Mortars and Grenades are among the most common items of UXO encountered in the UK and therefore the possibility cannot be discounted that they were used on site. They are commonly encountered in areas used by the military for training and are often found discarded on or near historic military bases. Examples of Grenades, Mortars and Home Guard weapons are presented in ***Annex I***.

Items of ordnance do not become inert or lose their effectiveness with age. Time can indeed cause items to become more sensitive and less stable. This applies equally to items submerged in water or embedded in silts, clays or similar materials. The greatest risk occurs when an item of ordnance is struck or interfered with. This is likely to occur when mechanical equipment is used or when unqualified personnel pick up munitions.

10.2.2. Mortars

A mortar bomb is a fin-stabilised munition, normally nose-fuzed and fitted with its own propelling charge (primary cartridge). Range is increased by adding extra propellant (augmenting charges). They are either HE or Carrier and generally identified by their tear-dropped shape (older variants however are parallel sided) and a finned 'spigot tube' screwed or welded to the rear end of the body housing the propellant charge.

A mortar relies on a striker hitting a detonator for explosion to occur. It is possible that the striker may already be in contact with the detonator and that only a slight increase in pressure would be required for initiation. Discarded augmenting charges are often encountered around mortar firing areas/bases.

10.2.3. Grenades

A grenade is a short range weapon which may be thrown by hand, fired from the end of a rifle or projected/propelled from a special purpose grenade launcher. They are divided into two categories; HE and Carrier (generally smoke). As with mortars, a grenade striker may either be in contact with the detonator or still be retained by a spring under tension, and therefore shock may cause it to function. A grenade can have an explosive range of 15-20m. Common older variants have a classic 'pineapple' shape; modern grenades tend to be smooth-sided.

10.3. Projectiles

In general, projectiles fall into two categories – Shot and Filling; see below.

- Practice shot – Used over sea ranges. These projectiles are usually solid cast iron of the same weight as the service projectile.
- Proof shot – For the proof of guns, howitzers and charges. They are made of forged steel of the same weight as the corresponding service projectile.
- Paper shot – Used to test the mounting of guns which cannot fire service projectiles owing to their position (i.e. close to occupied areas).
- Case shot - Generally consisting of three or more long steel segments held in position and filled with bullets allowing them to escape during firing.
- HE Fill – Designed to cause damage to material by the force of their burst or to personnel and aircraft by fragmentation.
- Smoke Fill – Used for the production of smoke screens, various fillings are used, the commonest being white phosphorus.
- Shrapnel Fill – Designed to be used primarily against personnel these are filled with the maximum amount of bullets possible.
- Star Fill - Designed to illuminate an area or target.

10.4. Anti-Aircraft Shells

These shells are frequently mistakenly identified as small German air-delivered bombs, but are differentiated by the copper driving band found in front of the base. Although the larger unexploded projectiles could enter the ground they did not have great penetration ability and are therefore likely to be found close to WWII ground level. With a HE fill and fragmentation hazard these items of UXO also present a significant risk if encountered.

The smaller 40mm projectiles are similar in appearance and effect to small arms ammunition and, although still dangerous, present a lower risk. Pictures of AAA projectiles are presented in ***Annex J***. Details of the most commonly deployed WWII AAA projectiles are shown below:

Gun type	Calibre	Shell Dimensions	Shell Weight	HE Fill Weight
3.7 Inch	94mm	94mm x 438mm	12.7kg	1.1kg
4.5 Inch	114mm	114mm x 578mm	24.7kg	1.7kg
40mm	40mm	40mm x 311mm	0.84kg	70g

10.5. Miscellaneous

When working on land used currently or historically by the military, all manner of explosive ordnance related items dating back over 100 years could be encountered. These may include practice (dummy) items, experimental weapons and other miscellanea such as detonators, pyrotechnics (flares, training aids, etc) and fuzes. In particular, it should be noted that, although small, detonators contain enough primary explosive to cause serious injury.

11. The Threat from German Aerial Bombing

11.1. General Bombing History of Shoeburyness

11.1.1. First World War

During WWI the south-east of England was targeted and bombed by Zeppelin Airships and by Gotha and Giant fixed-wing aircraft. A bomb plot map of the region (not included) confirms that Southend was attacked on a number of occasions. This is substantiated by anecdotal evidence which recounts Zeppelin and Gotha raids over Southend in the summer of 1917. During one raid on the 5th June 1917 one of the new Shoebury AA guns assisted in bringing down a Gotha bomber.

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

11.1.2. Second World War

Located relatively close to London, as well as at the mouth of the Thames Estuary, Shoeburyness occupied a position where a significant amount of aerial activity took place. Dog fights between British and German aircraft on their way to attack London regularly took place over the Thames Estuary, as did offensive mine laying sorties and German raids on east coast shipping off the Essex coast.

There were not many significant Luftwaffe bombing targets in the local area. Shoebury and Southend were small towns with no naval facilities and little industry. Apart from RAF Rochford, a Fighter Command base approximately 7km to the north-west, the only other significant target area would have been the Shoeburyness area itself, with its barracks and coastal defence guns.

Indeed a Luftwaffe aerial target photograph (presented in ***Annex K***) highlights three coastal batteries within the study area. It should be noted however that the only features highlighted are coastal batteries, therefore it is possible that the Luftwaffe assumed these were just anti-invasion defences, rather than part of a larger, important trial and proofing facility. This is substantiated by an anecdotal account suggesting that the New Ranges were never specifically bombed by a formation of aircraft and was only ever subjected to raids by solitary aircraft.

Shoebury town however was bombed by multiple aircraft on a number of occasions, probably due to the fact it was a garrison town. In addition, the study area would have been vulnerable to 'Tip and Run' bombing incidents. These occurred when enemy aircraft, confronted by barrage balloons, intense anti-aircraft fire or RAF fighter interception, would jettison their bomb loads prematurely and indiscriminately in order to escape the combat zone and return to base.

Records of bombing incidents in the civilian areas of Essex were collected by the Air Raid Precautions wardens and collated by the Civil Defence Office. Some other organisations, such as the London Port Authority and railways, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics.

11.2. Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the County Borough of Southend (within which the site was located during WWII) between 1940 and 1945:

Record of German Ordnance Dropped on the County Borough of Southend	
Area Acreage	10,284
High Explosive Bombs (All Types)	388
Parachute Mines	9
Oil Bombs	5
Phosphorous Bombs	24
Fire Pot	1
Pilotless Aircraft (V1)	4
Long Range Rocket (V2)	2
Total	433
Number of items per 1,000 acres	**42.1**

Source: Home Office Statistics

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. However one local ARP written incident report regarding such weapons was located:

22/03/1944 - 01:13 – 1kg Incendiaries fell from New Farm to War Department Land (Old Ranges).

Although the incendiaries are not particularly significant in the threat they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous.

11.3. Site Specific WWII Bombing Records

11.3.1. Southend Consolidated ARP Bomb Census Map

A Southend bomb census map, recording bomb strikes throughout the entire German bombing campaign, was obtained from the Essex Record Office and is presented in ***Annex L***.

This map records one high explosive bomb, anti-personnel bomb or AA shell bomb strike on site as well as a further four at its eastern, north-eastern and western boundaries. An unexploded high explosive bomb, anti-personnel bomb or AA shell is also plotted just within the eastern end of the study area.

11.3.2. Anecdotal Evidence of Bombing

Anecdotal accounts of local bombing incidents were sought from publications and the internet. The following account was located:

The most significant raid on Shoebury occurred on the 18th August 1940 and involved a force of approximately 50 Heinkel 111 medium bombers which jettisoned numerous HE bombs over the village following an aborted attack on North Weald airfield. Thirty-one bombs were recorded in Shoebury with a further 200 recorded on the neighbouring tidal sands. Minor damage was caused to the Royal Artillery buildings, tracks and cranes.

Note that although the precise locations of strikes are not known, this raid could have resulted in German bombs landing on site.

11.3.3. Abandoned Bombs

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

Given the inaccuracy of WWII records and the fact that these bombs were 'abandoned', their locations cannot be considered definitive, nor the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded. Dynasafe BACTEC holds no records of any officially registered abandoned bombs on site.

11.3.4. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the MoD Beach & Park Garrison site, the following parameters would be used:

- Geology - 5m of loose to medium dense silty SAND, 1m of loose silty SAND with gravel, 3m of stiff silty CLAY, >5m of very stiff laminated silty CLAY.

  Note the shallow geology on site is likely to vary significantly due to its size and proximity to the coast.

- Impact Angle and Velocity – 80-90^{O} from horizontal and 267 metres per second.
- Bomb Mass and Configuration – The 500kg SC (General Purpose) HE bomb, without retarder units or armour piercing nose. This was the largest of the common bombs used against Britain.

Taking into account the above-mentioned factors it has been assessed that a 500kg bomb would have had a maximum bomb penetration depth of up to **8m** below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth. This assessment has been made using generic geological information.

11.4. Likelihood of Post-raid UXO Detection

Utilising the available historical bombing records as reviewed in *Section 11.3*, it is possible to make an assessment of the likelihood that evidence of unexploded ordnance would have been noted on a site during the war and the incident dealt with or recorded at the time. Factors such as bombing density, frequency of access, ground cover, damage and failure rate have been taken into consideration.

11.4.1. Density of Bombing

Bombing density is an important consideration for assessing the possibility that UXBs remain in an area. A very high density of bombs can for example result in increased levels of damage sustained to structures, greater likelihood of errors in record keeping and a higher risk that UXBs fell unrecorded over the area.

The site was situated within an area of moderate bombing density, as confirmed by official statistics and bomb plot mapping.

11.4.2. Frequency of Access

UXO at sites where human access was infrequent would have a higher chance of being overlooked than at those sites which were subject to greater occupancy. The importance of a

site or facility to the war effort is also an important consideration as such sites are likely to have been both frequently accessed and are also likely to have been subject to post-raid checks for evidence of UXO.

Access would have varied greatly across the site during WWII. The barracks areas, range buildings, firing butts and environs would have been frequently accessed by soldiers, increasing the possibility of any German UXO being observed. Furthermore, within the developed localities post air raid checks for evidence of German UXO may have been carried out.

However it is likely that peripheral, unmaintained and apparently unused, parts of the Old Ranges were neglected. Consequently it is considered possible that a UXB could have fallen unnoticed here and remained undetected, especially since many air raids over Essex occurred at night.

11.4.3. Ground Cover

The degree and type of groundcover present during WWII would have a significant effect on the visual evidence at ground level which may have indicated the presence of buried UXO.

During WWII the site was partially developed, particularly in the north-eastern quarter, where barracks buildings were also surrounded by hard-standing. In addition, other ancillary structures were sporadically situated throughout the study area. Had a UXB struck these areas it will have caused obvious damage, even without detonating, and would have been observed / dealt with at the time.

However the vast majority of the study area comprised grass fields, saltings, sandy beach / shingle and mixed vegetation. Had a UXB fallen here, the resulting impact could have become obscured in such ground cover. Note that the entry hole of an SC50 UXB (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter.

11.4.4. Damage

If structures on a site have been subject to significant bomb or fire damage, rubble and debris are likely to have been present; similarly a HE bomb strike on open ground is likely to have resulted in a degree of soil disturbance. Under such conditions there is a greater risk of the entry holes of unexploded bombs dropped during subsequent raids being obscured and going unnoticed.

No definitive evidence of German bomb damage on site was identified.

11.4.5. Bomb Failure Rate

There is no evidence to suggest that the bomb failure rate in the vicinity of the site would have been different from the “approximately 10%” figure normally used.

12. The Threat Posed by German Unexploded Ordnance

12.1. Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today. Detailed illustrations of German air delivered ordnance are presented at ***Annex M***.

- HE Bombs: In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the high explosive) though large bombs of up to 2000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Post-raid surveys would not always have spotted the entry hole or other indications that a bomb penetrated the ground and failed to explode and contemporary ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. Unexploded HE bombs therefore present the greatest risk to present–day intrusive works.

- Blast Bombs/ Parachute Mines: Blast bombs generally had a slow rate of descent and were extremely unlikely to have penetrated the ground. Non-retarded mines would have shattered on most ground types, if they had failed to explode. There have been extreme cases when these items have been found unexploded, but this was where the ground was either very soft or where standing water had reduced the impact. Dynasafe BACTEC does not consider there to be a significant threat from this type of munition on land.
- Large incendiary bombs: This type of bomb ranged in size from 36kg to 255kg and had a number of inflammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface but their shape and weight meant that they did have penetration capability. If they penetrated the ground complete combustion did not always occur and in such cases they remain a risk to intrusive works.
- 1 kg Incendiary Bombs (IB): These bombs, which were jettisoned from air-dropped containers, were unlikely to penetrate the ground and in urban areas would usually have been located in post-raid surveys. However, if bombs did not initiate and fell in water or dense vegetation, or became mixed with rubble in bomb damaged areas they could have been overlooked. Some variants had explosive heads and these present a risk of detonation during intrusive works.
- Anti-personnel (AP) Bomblets: AP bombs had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.
- Specialist Bombs (smoke, flare, etc): These types do not contain high explosive and therefore a detonation consequence is unlikely. They were not designed to penetrate the ground.

12.2. German Air-delivered Ordnance Failure Rate

It has been estimated that 10% of the German HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time, and is probably an underestimate.

The reasons for failures include:

- Fuze or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.
- Clockwork mechanism failure in delayed action bombs.
- Failure of the bomber aircraft to arm the bombs (charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.
- Jettison of the bomb before it was armed or from a very low altitude. Most likely if the bomber was under attack or crashing.

War Office Statistics document that a daily average of 84 bombs which failed to function were dropped on civilian targets in Great Britain between 21st September 1940 and 5th July 1941. 1 in 12 of these (probably mostly fitted with time delay fuzes) exploded sometime after they fell - the remainder were unintentional failures.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50 kg and over (i.e. German bombs), 7000 AAA shells and 300,000 beach mines. These operations resulted in the deaths of 394 officers and men. However, unexploded ordnance is still regularly encountered across the UK (see recent press articles, ***Annex N-1***)

12.3. UXB Ground Penetration

12.3.1. General Considerations

The actual penetration depth of aerial delivered bombs into the ground will have been determined by the mass and shape of the bomb, the velocity and angle of the bomb on impact (dependent on the height of release) and the nature of the ground and ground cover; the softer the ground, the greater the potential penetration. Peat, alluvium and soft clays are

easier to penetrate than gravel and sand. Bombs are brought to rest or are commonly deflected by bedrock or large boulders.

12.3.2. The "J" Curve Effect

An air-dropped bomb falling from normal bombing altitude (say 5000m) into homogeneous ground will continue its line of flight but turn in an upwards curve towards the surface as it comes to rest. This offset from vertical is generally thought to be about one third of the penetration depth, but can be up to 15m depending on ground conditions or the bomb's angle of impact.

12.3.3. Second World War Bomb Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1328 bombs as reported by Bomb Disposal, mostly in the London area. They then came to conclusions as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

The median penetration of 430 x 50kg German bombs in London Clay was 4.6m and the maximum penetration observed for the SC50 bomb was 9m.

They concluded that the largest common German bomb, 500kg, had a likely penetration depth of 6m in sand or gravel but 8.7m in clay. The maximum observed depth for a 500kg bomb was 10.2m and for a 1000kg bomb 12.7m. Theoretical calculations suggested that significantly greater penetration depths were probable.

12.4. Initiation of Unexploded Bombs

Unexploded bombs do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms:

- Direct impact onto the main body of the bomb: Unless the fuze or fuze pocket is struck, there needs to be a significant impact (e.g. from piling or large and violent mechanical excavation) to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
- Re-starting the clock timer in the fuze: Only a small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years that would prevent clockwork mechanisms from functioning, nevertheless it was reported that the fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-commence.
- Induction of a static charge, causing a current in an electric fuze: The majority of German WWII bombs employed electric fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years such that the fuze circuit could not be activated.
- Friction impact initiating the (shock-sensitive) fuze explosive: This is the most likely scenario resulting in the bomb detonating.

Annex N-2 details UXB incidents where intrusive works have caused UXBs to detonate, resulting in death or injury and damage to plant.

13. Unexploded Ordnance Clearance and Post-WWII Ground Works

13.1. General

The extent to which any ordnance clearance activities have taken place on site or extensive ground works have occurred is relevant since on the one hand they may indicate previous ordnance contamination but also may have reduced the risk that ordnance remains undiscovered.

13.2. British Army EOD Clearance Tasks

Dynasafe BACTEC holds a number of official records of Army UXO disposal operations during and following WWII, obtained from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD). The following tasks were noted within the site boundary (see ***Annex O***):

- December 1966 - An area of hard-standing (0.13Ha) near the Horseshoe Barracks (Old Ranges) was cleared. 142 items of UXO were found (122 projectiles and 20 cannon balls).
- July to November 1982 – An area of 40Ha within the Old Ranges was surveyed and cleared. 585 items of UXO were found including 215 live HE shells and several mortars / grenades. Note the precise coverage of this area is not known, however 40Ha is a very large area and therefore is likely to have covered some or all of the onshore study area.

In addition a massive EOD task was carried out on the Shoeburyness foreshore in 1973:

- 1973 - A 2,000 acre area of Maplin Sands was cleared. An EOD team spent 20 months recovering items of UXO prior to the construction of the planned 3rd London airport. They recovered 63,452 items (of which 14,178 were too dangerous to move and had to be destroyed in situ). A photograph presented in ***Annex P*** shows some of the larger items of UXO found during this task.

13.2.1. Dynasafe BACTEC EOD Tasks

Dynasafe BACTEC has undertaken EOD clearance tasks in the Shoeburyness area over a period of several years and has recovered numerous items of UXO.

- In March 2000, two items of inert small arms ammunition were recovered from a plot in the Old Ranges.
- In October 2002, a total of 35 items of small arms ammunition were recovered from the Old Ranges Garrison Area.
- In 2003, a live 3" Mortar bomb was recovered from North Camp, Shoeburyness.
- 2004 - 2005, 51 live and inert items of shot projectiles etc recovered during repair work to the sea wall within the Old Ranges.
- In 2007 - 2009, BACTEC recovered and disposed of hundreds of items of UXO, inert munitions and munitions paraphernalia within various parts of the Old Ranges. A map recording the localities of these finds, as well as corresponding photographs is presented in ***Annex Q***.

It should be noted that East Beach (immediately north-east of the study area) has been cleared of UXO according to the MOD and is open to the public. However Dynasafe BACTEC has since recovered additional UXO, partially buried in the sands of the East Beach foreshore, suggesting this beach was in fact not completely cleared of UXO.

Alternatively (and more likely), additional items of UXO (originating from deeper water seabed) are occasionally washed up on the beaches, particularly during stormy weather. This is unsurprising considering the huge size of the Maplin Sands offshore firing range area and the enormous quantity of shells fired seaward onto the sand flats during a period of >150 years.

13.3. Post WWII Redevelopment

With the exception of some demolition works, and possible laying of hard-standing, the study area appears to have remained undeveloped since the closure of the Old Ranges.

14. The Overall Explosive Ordnance Threat Assessment

14.1. General Considerations

Taking into account the quality of the historical evidence, the assessment of the overall threat to the proposed works from unexploded ordnance must evaluate the following risks:

- That the site was contaminated with unexploded ordnance
- That unexploded ordnance remains on site
- That such items will be encountered during the proposed works
- That ordnance may be activated by the works operations
- The consequences of encountering or initiating ordnance

14.2. The Risk that the Site was Contaminated with Unexploded Ordnance

For the reasons discussed in *Sections 9* and *11* Dynasafe BACTEC believes that there is a risk that the site was contaminated with UXO.

British UXO

- The site is occupied by a former MoD live small arms and artillery range (The Old Ranges), dating back to the 19th Century. Note however, clusters of HE blast craters on WWII-era aerial photography suggest that parts of the range have also been used historically for either demolitions (EOD) training or infantry training with grenades, mortars, etc.
- The 'housekeeping' at military ranges is known to have been poor during the 19th and 20th centuries with faulty, surplus or expended items of UXO often left in situ, burnt, buried or misplaced on site, resulting in legacy of UXO contamination up to the present day. This is substantiated by numerous UXO finds made by both Army and Dynasafe BACTEC EOD Engineers within the study area.
- During the 19th Century (in particular) seaward artillery firing within the Old Ranges would have resulted in numerous live HE and inert shot projectiles landing on Maplin Sands. Since then the beaches within the study area have been contaminated with this UXO, as it continues to be washed ashore.
- Historical OS mapping records two neighbouring earth-bunded buildings on site, used for the storage of large quantities of ammunition. In addition, a Heavy Anti-Aircraft (HAA) battery was constructed on site in the late 1930s and several coastal batteries have persisted since the 19th Century. Therefore significant quantities of HE projectiles would have been stored within magazines at these localities. Previous experience at similar sites suggests faulty shells were occasionally discarded in the immediate surrounding area, subsequently becoming buried.
- As a coastal site within a vulnerable location (relatively close to occupied Europe) the beaches on were fortified with coastal gun batteries and anti-tank defences during 1940, when the threat of German invasion was high. Regular Army and Home Guard troops would have stationed locally and will likely have carried out live fire beach defence exercises, which could have resulted in UXO contamination on site.
- Home Guard troops in particular are known to have buried caches of grenades, ammunition, etc in strategic locations, close to likely invasion beaches and therefore the possibility that such activities occurred within the site boundary cannot be discounted.
- Three HAA batteries were positioned within a 3km radius of the site during WWII. Furthermore, anecdotal accounts suggest that during 1944 several additional batteries were installed on the Shoeburyness islands to counter the V1 Flying Bomb threat. The undeveloped nature of the site coupled with increased Luftwaffe activity in the area during WWII suggests there is an elevated risk of expended yet unexploded AA shell contamination.
- Note it is highly unlikely that any ammunition would have been handled / utilised on the cricket pitch, which has been present since the establishment of the Old Ranges. Similarly an adjacent section of recreational land (including some tennis courts) appears to be separated from the weapons ranges / beach area, suggesting UXO contamination is less likely here.

German UXO

- Positioned relatively close to London, as well as at the mouth of the Thames Estuary Luftwaffe flight path, Shoeburyness was positioned close to any area of increased aerial activity during 1940 and 1941. A 1939 German aerial target photograph earmarks three coastal batteries within the site, for destruction. Consequently several small scale and one

medium scale air raids occurred in the local area. The Old Ranges therefore occupied an area of moderate bombing density.

- A German bomb census map of the area records one HE bomb, anti-personnel bomb or AA shell bomb strike on site as well as a further four at its eastern, north-eastern and western boundaries. An unexploded high explosive bomb, anti-personnel bomb or AA shell is also plotted just within the eastern end of the study area.
- A large portion of the study area comprised isolated open ground during WWII and therefore will not have been accessed as frequently / regularly as the developed barracks area. Indeed some peripheral localities may have been neglected entirely. Consequently it is considered possible that a UXB could have fallen unnoticed on site, especially since many air raids in the wider area occurred at night.
- Furthermore, had such an incident occurred, the resulting evidence may have remained undetected in the unmaintained grass fields, saltings, sandy beaches / shingle that occupied much of the site. Note that the entry hole of an SC50 UXB (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter and therefore easily obscured in such ground cover.

14.3. The Risk that Unexploded Ordnance Remains on Site

An extensive EOD task carried out by the Army within the Old Ranges during 1982, will have mitigated much of the risk from UXO on site, however subsequent EOD tasks carried out by Dynasafe BACTEC within the Old Ranges suggest this was not a comprehensive clearance, as additional UXO was encountered. Furthermore the site has remained undeveloped and therefore there has been no risk mitigation from construction and associated earth works within the MoD Beach & Park Garrison study area.

There is also evidence that tidal currents and wave action have resulted in additional items of UXO being washed up on the study area beaches. Furthermore, it is possible (especially during storm conditions) that such items could then become shallow buried in beach sediments / shingle.

14.4. The Risk that Ordnance may be Encountered during the Works

The majority of the UXO risk identified on site is from shallow buried British UXO and therefore even minor excavations could encounter UXO. The overall risk will depend on the extent of the works, i.e. the number and volume of excavations.

It should be noted that since an air-dropped bomb may come to rest at any depth between just below ground level and its maximum penetration depth there is also a chance that such an item could be encountered during shallow excavations into the original WWII ground level.

Items of UXO washed up on the foreshore are likely to accumulate along the groynes, where they would then become buried by successive periods of sedimentation. Consequently maintenance of the groynes is likely to represent one of the more risky types of construction work at the MoD Beach & Park Garrison site.

14.5. The Risk that Ordnance may be Initiated

The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. The most violent activity on most construction sites is percussive piling.

As a result items that are shallow buried present a lower risk than those that are deep buried, since the force of impact is usually lower and they are more likely to be observed – when immediate mitigating actions can be taken.

14.6. The Consequences of Encountering or Initiating Ordnance

Clearly the consequences of an inadvertent detonation of UXO during construction operations would be catastrophic with a serious risk to life, damage to plant and a total site shutdown during follow-up investigations.

Since the risk of initiating ordnance is comparatively low if appropriate mitigation measures are undertaken, the most important consequence of the discovery of ordnance will be economic. This would be particularly so in the case of high profile locations and could involve the evacuation of the public. The unexpected discovery of ordnance may require the closing of the site for any time between a few hours and a week with a potentially significant cost in lost time. Note also that the suspected find of ordnance, if handled solely through the authorities, may also involve loss of production since the first action of the Police in most cases will be to isolate the locale whilst awaiting military assistance, even if this turns out to have been unnecessary.

14.7. Dynasafe BACTEC's Assessment

Taking into consideration the findings of this study, Dynasafe BACTEC considers the UXO risk across the site to be heterogeneous and can therefore be sub-divided into ***HIGH, LOW-MEDIUM*** and ***LOW*** risk zones. These are described below and plotted on a Risk Map presented in ***Annex R***.

High Risk Zone: Area of historical weapons ranges and beach / foreshore area

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German High Explosive Bombs			✓	
German 1kg Incendiary Bombs		✓		
British Anti-Aircraft Shells			✓	
British / Allied Small Arms Ammunition				✓
British / Allied Land Service Ammunition				✓

Low-Medium Risk Zone: Area of historical open ground / recreation space away from the weapons ranges

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German High Explosive Bombs		✓		
German 1kg Incendiary Bombs		✓		
British Anti-Aircraft Shells		✓		
British / Allied Small Arms Ammunition		✓		
British / Allied Land Service Ammunition		✓		

Low Risk Zone: The site of a cricket pitch, present since the establishment of the Old Ranges

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German High Explosive Bombs		✓		
German 1kg Incendiary Bombs		✓		
British Anti-Aircraft Shells		✓		
British / Allied Small Arms Ammunition		✓		
British / Allied Land Service Ammunition		✓		

15. Proposed Risk Mitigation Methodology

15.1. General

The MoD Beach & Park Garrison site is large and complex with a likely high concentration of UXO contamination in some parts and therefore it is recommended that a meeting be held between senior Dynasafe BACTEC EOD personnel and Southend-on-Sea Borough Council to discuss the best options for mitigating the UXO risk during future maintenance works.

It is understood that the proposal requires the section of beach and foreshore within the study area to be reopened to the public. Dynasafe BACTEC's previous experience clearing UXO in this locality would be invaluable in forming a cost effective Risk Mitigation Strategy.

Such a Risk Mitigation Strategy for any future works is likely to involve a combination of the following mitigation measures, where deemed necessary and appropriate:

15.2. Risk Mitigation Measure Options

All Risk Zones

- ***Explosive Ordnance Safety and Awareness Briefings to any personnel conducting intrusive works:*** A specialised briefing is always advisable when there is a possibility of explosive ordnance contamination. It is an essential component of the Health & Safety Plan for the site and conforms to requirements of CDM Regulations 2007. All personnel working on the site should be instructed on the identification of UXB, actions to be taken to alert site management and to keep people and equipment away from the hazard. Posters and information of a general nature on the UXB threat should be held in the site office for reference and as a reminder.
- ***The provision of Unexploded Ordnance Site Safety Instructions:*** These written instructions contain information detailing actions to be taken in the event that unexploded ordnance is discovered. They are to be retained on site and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.

Low-Medium and High Risk Zones only

- ***Explosive Ordnance Disposal (EOD) Engineer presence on site to support any shallow intrusive works:*** When on site the role of the EOD Engineer would include; monitoring works using visual recognition and instrumentation and immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site; providing Explosive Ordnance Safety and Awareness briefings to any staff that have not received them earlier and advise staff of the need to modify working practices to take account of the ordnance threat, and finally to aid Incident Management which would involve liaison with the local authorities and Police should ordnance be identified and present an explosive hazard.
- ***Explosive Ordnance Sifter Deployed to Clear Beach Sediments:*** Dynasafe BACTEC can provide equipment specifically designed to search large volumes of loose beach sediment in locations known to been contaminated with UXO. A UXO sifter is a large horizontal drum, wrapped with a gauze mesh and fitted to the front of an armoured excavator. Sediment is introduced into the drum, which rotates. As it spins, sediment is expelled leaving any items of UXO inside, which can then be removed, identified and disposed of by EOD Engineers. The sifter requires a team of two EOD Engineers dressed in body armour.

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

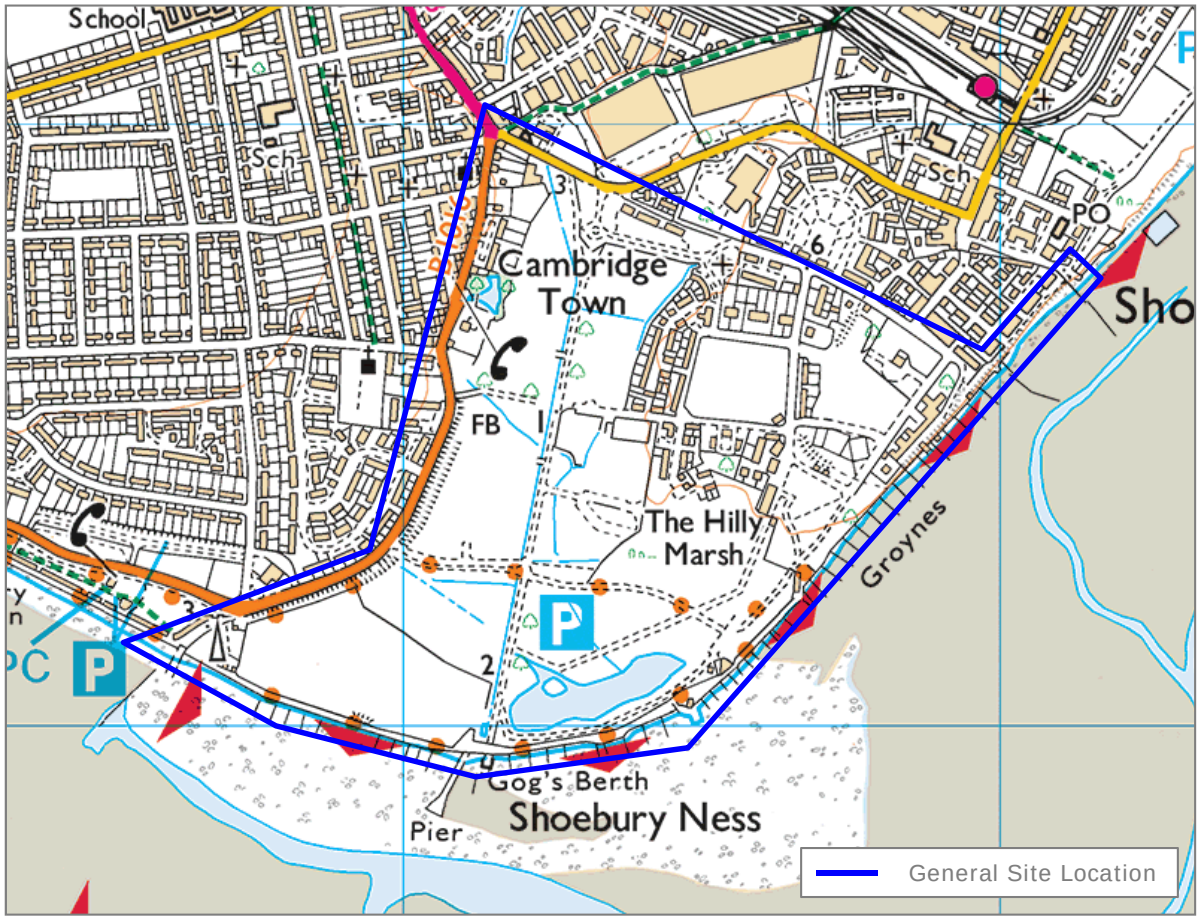
Dynasafe BACTEC Limited *27th November 2015*

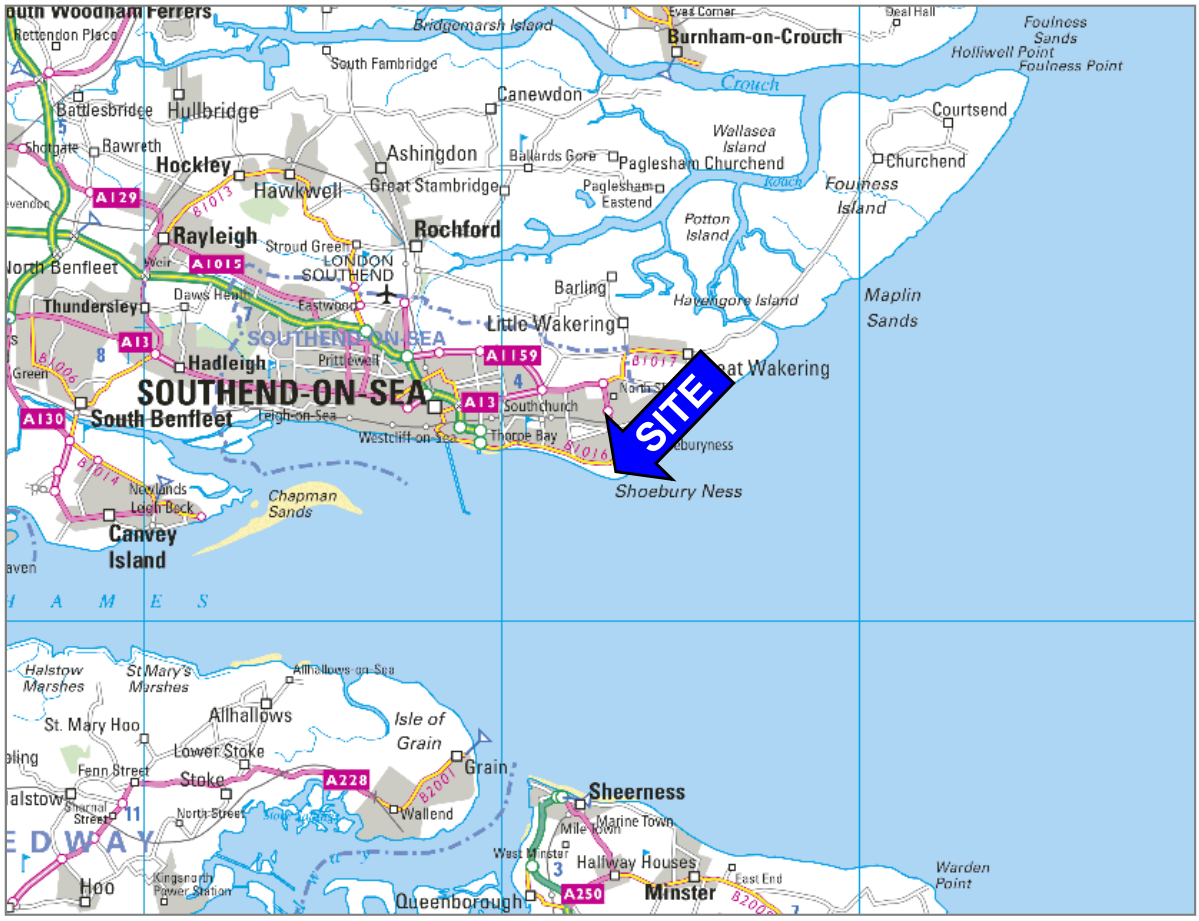
Bibliography

The key published documents consulted during this assessment are listed below:

- Hill, T., Guns and Gunners at Shoeburyness, Baron. 2000
- Dobinson, C., AA Command: Britain's Anti-Aircraft Defences of the Second World War, Methuen. 2001.
- Fegan, T., The Baby Killers': German Air raids on Britain in the First World War, Leo Cooper Ltd. 2002.
- Fleischer, W., *German Air-Dropped Weapons to 1945,* Midland Publishing. 2004.
- Jappy, M. J., Danger UXB: The Remarkable Story of the Disposal of Unexploded Bombs during the Second World War. Channel 4 Books, 2001.
- Price, A., Blitz on Britain, The Bomber Attacks on the United Kingdom 1939 – 1945, Purnell Book Services Ltd. 1977.
- Ramsey, W., *The Blitz Then and Now, Volume 1*, Battle of Britain Prints Limited. 1987.
- Ramsey, W., *The Blitz Then and Now, Volume 2*, Battle of Britain Prints Limited. 1988.
- Ramsey, W., *The Blitz Then and Now, Volume 3*, Battle of Britain Prints Limited. 1990.
- Whiting, C., Britain Under Fire: The Bombing of Britain's Cities 1940-1945, Pen & Sword Books Ltd. 1999.

North





Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

North

General Site Location

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Google Earth ™ Mapping Services		

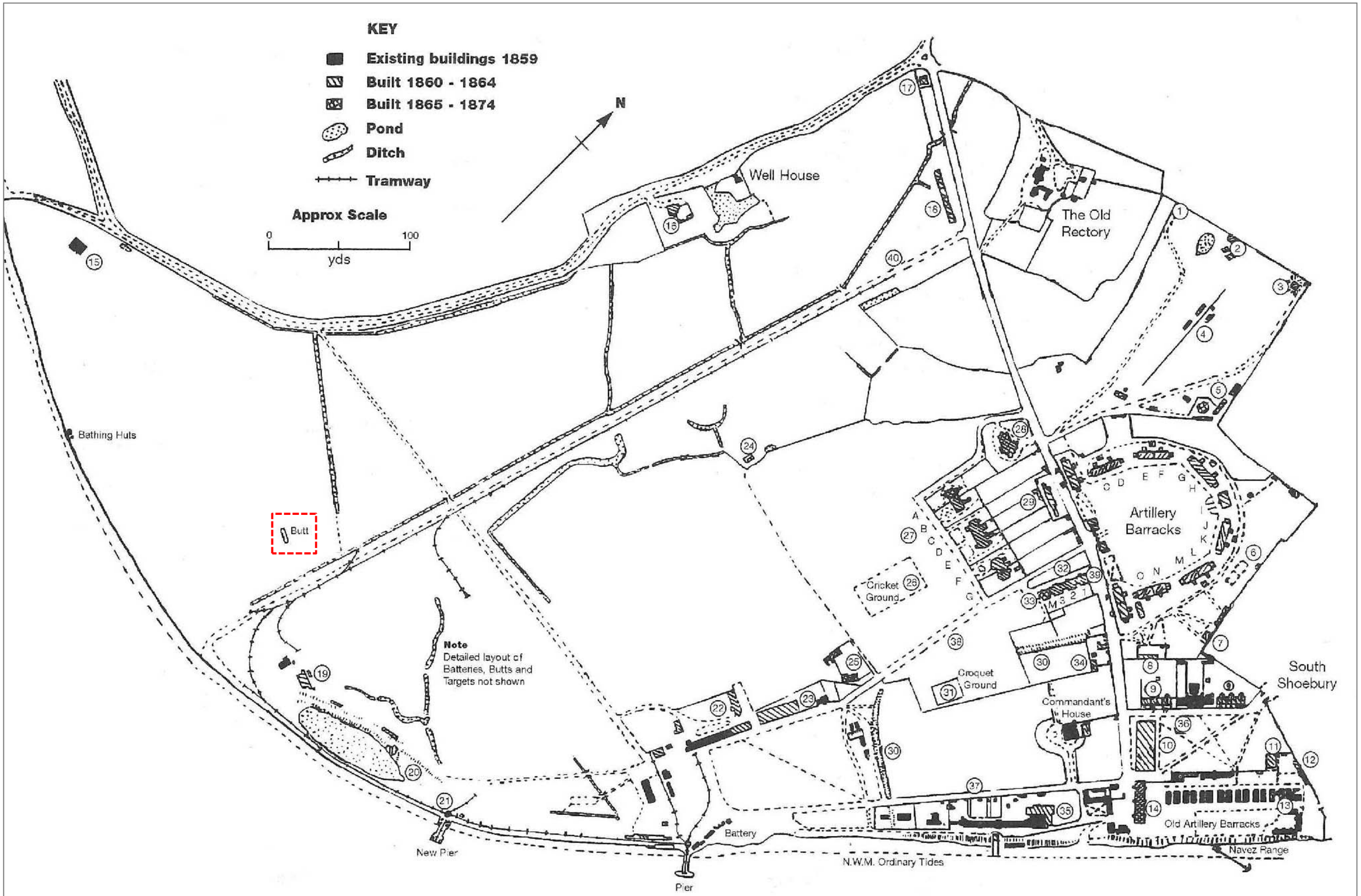
North

Legend

- Inner Sea Danger Area as defined in Shoeburyness Artillery Ranges Bye Laws 1936
- Outer Sea Danger Area as defined in Shoeburyness Artillery Ranges Bye Laws 1936
- Gunners_Park_Land_already_in_SBC_ownership
- Area of "beach" to be transferred to SBC [8336 sq m]
- Boundary of transfer area. NOTE Does not include foreshore below mean high water mark under Barge Pier. Structure only transfers to SBC

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Southend-on-Sea Borough Council		

North



Rifle range butts

Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source:	Hill, T., Guns and Gunners at Shoeburyness, Baron. 2000	

North

Rifle range and butts

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: F!ND Maps		

Rifle range and butts

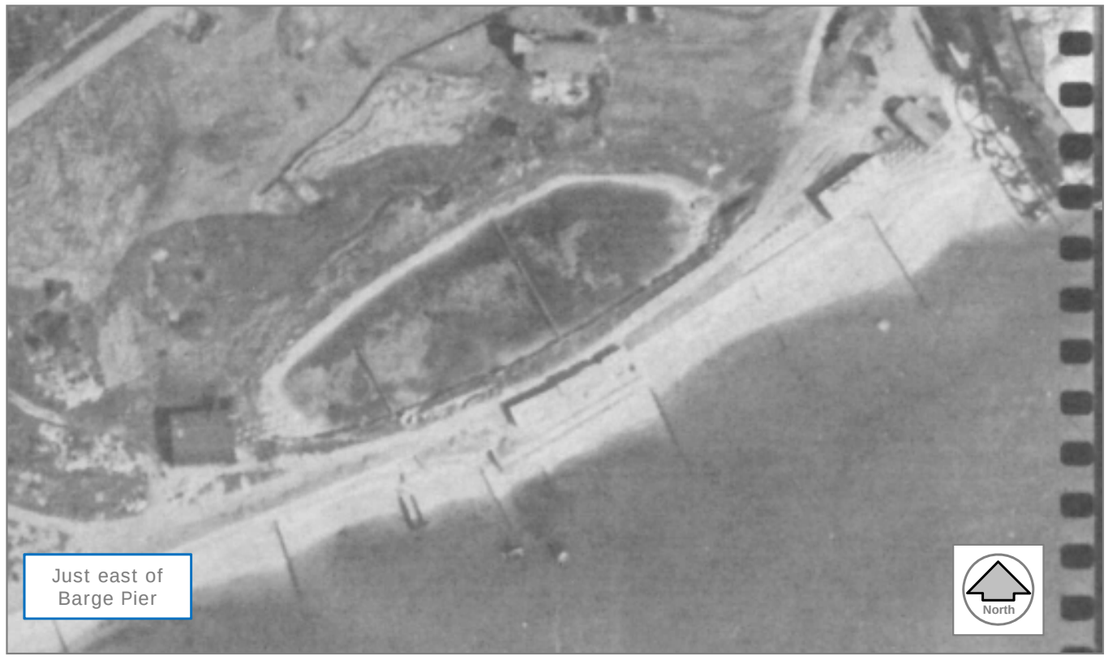
Bunded ammunition storage buildings

Report Reference:	Client:
6180TA Rev-3	Southend-on-Sea Borough Council
	Project: MoD Beach & Park Garrison Site
Source:	F!ND Maps

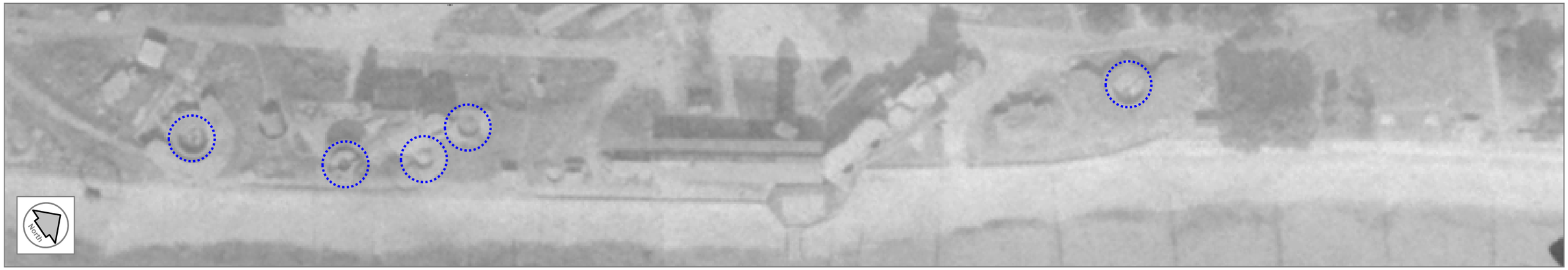
North

- Concentration of HE blast craters
- WWII-era anti-tank pimples – 3 x parallel rows

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Historic England		



Note: These images cover the beach area from a point just east of Barge Pier in the south-west to the start of Shoebury East Beach in the north-east.

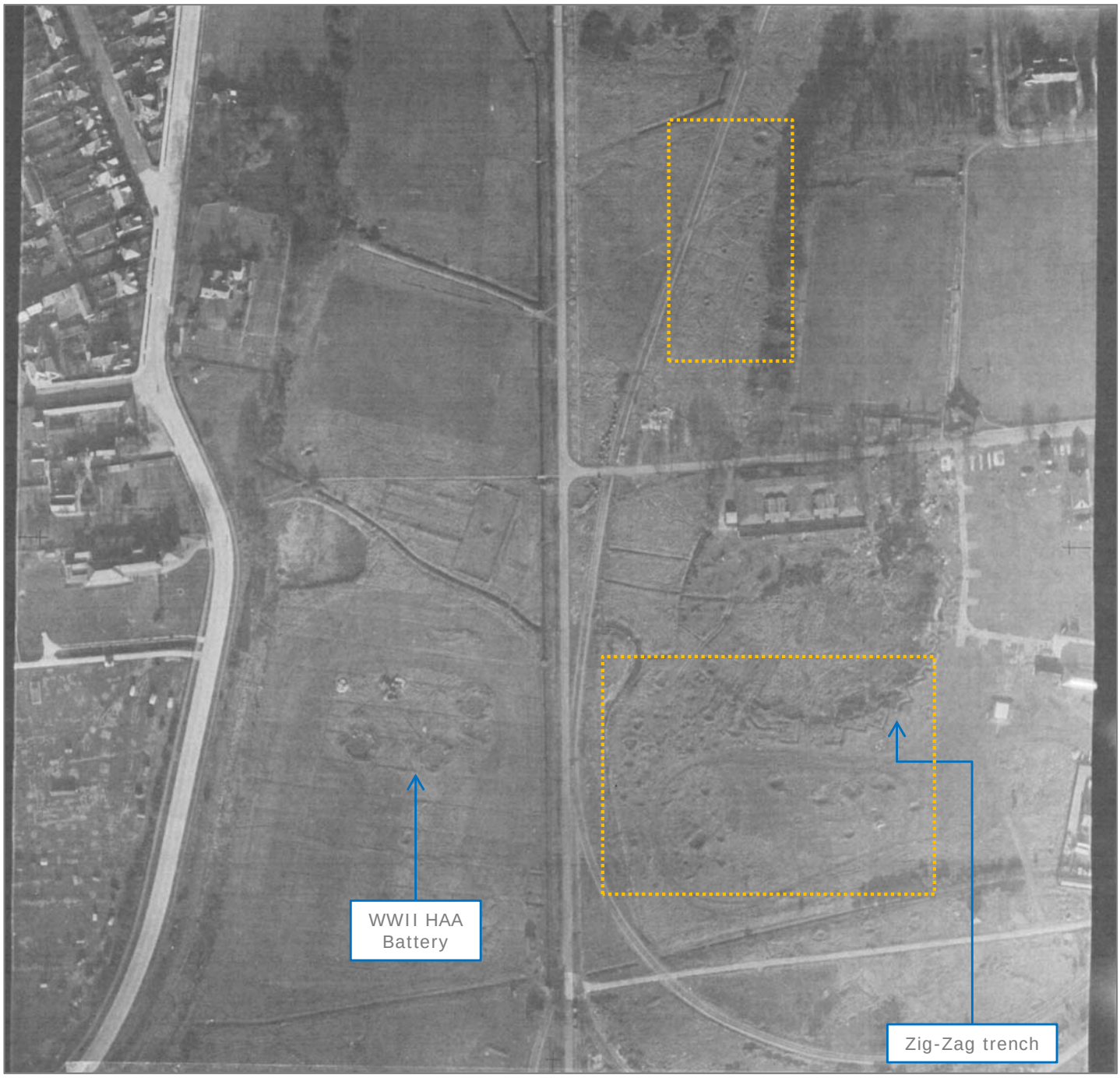


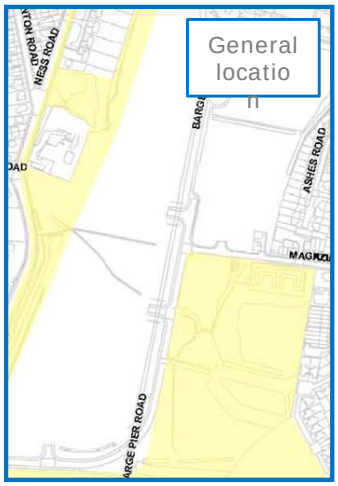
Edge of Shoebury East Beach

Coastal gun battery

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Historic England		

North





Concentration of HE blast craters

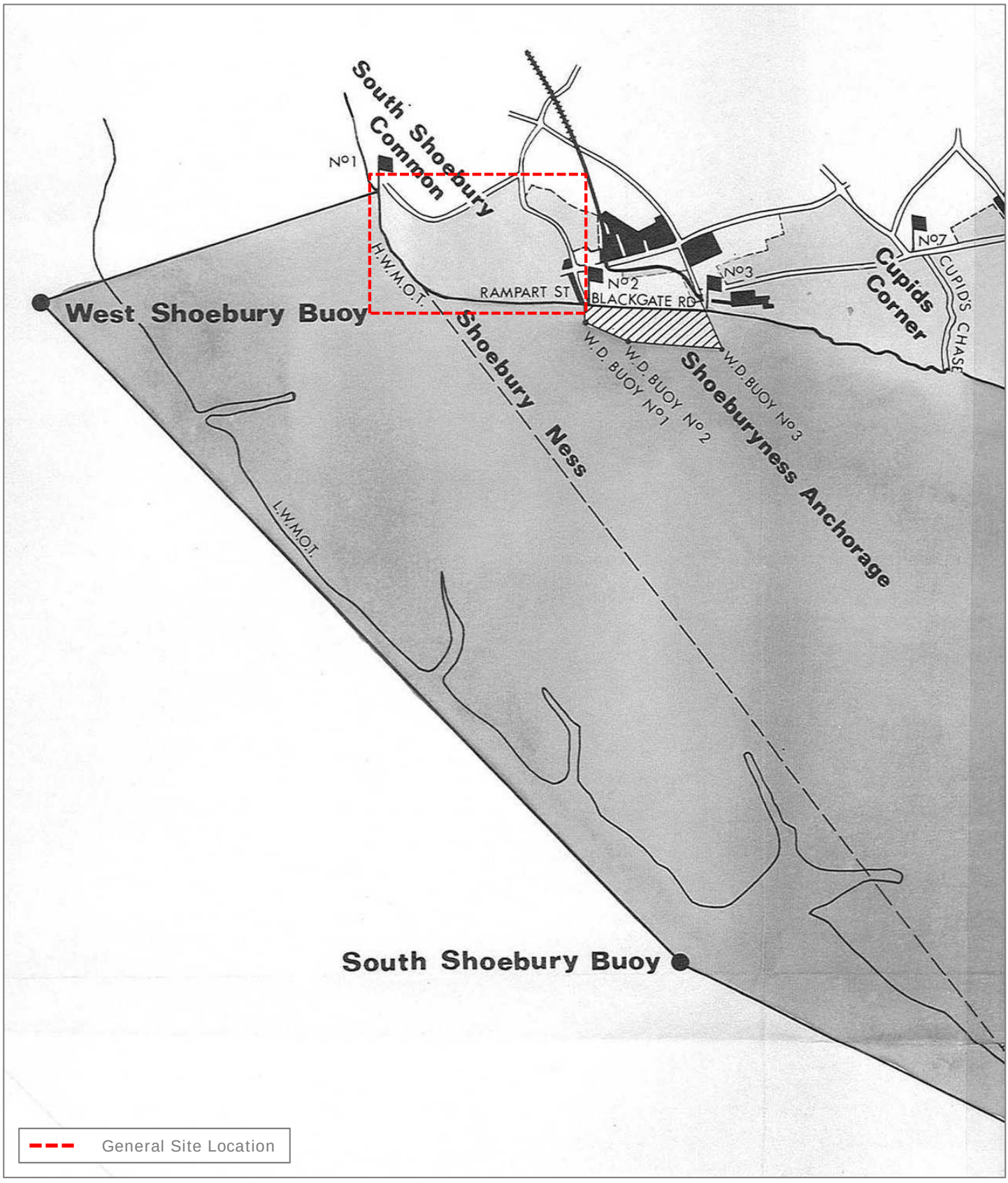
Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: Historic England

North

Concentration of HE blast craters

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Historic England		



Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: The National Archives

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23 July 2010 Last updated at 18:28

Covert British troops 'could have buried' WWII devices

World War II incendiary devices found on a building site in Gloucestershire could have been left by covert British troops, according to researchers.

The bombs were put into vats of water to make them safe

More than 20 phosphorus bombs were unearthed in Birdlip after a digger hit one, causing it to burst into flames.

A former worker at the site said he saw a Home Guard officer burying objects there 65 years ago.

The Coleshill Auxiliary Research Team said auxiliary officers often used Home Guard uniforms as cover.

Thursday, September 10 2015

KM KentOnline

The UK's fastest-growing regional news network

Army bomb disposal team called to Blacksole Bridge in Herne Bay

Comments | 3

by Aidan Barlow abarlow@thekmgroup.co.uk 08 July 2015

It was like a scene from Dad's Army when Army bomb disposal experts found wartime explosives made by the Home Guard in makeshift bottles.

A team was called to the Blacksole Bridge in Herne Bay after the wartime bombs were found.

The team from the Royal Logistics Corps set up a 30 metre exclusion zone for pedestrians around the railway embankment after the suspected homemade phosphorous bombs were found.

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Treasure hunter stumbles on deadly Dad's Army bomb cache

By MAIL ONLINE REPORTER
Last updated at 4:06 PM on 9th July 2010

Comments (0) | Add to My Stories

A treasure hunter escaped serious injury when he unearthed a cache of bombs that were buried by the Home Guard during the darkest days of World War 2.

The weapons - primed to go off when they made contact with the air - were secreted on a beach by a Captain Mainwaring of the day.

Loaded with dangerous benzene and phosphorus, the Dad's Army-style team would have used them in battle against Nazi troops in the event of invasion.

'Are you sure that's unsafe?': The Home Guard's stash of bombs finally goes off, 70 years late

Eastbourne Herald

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VIDEO: Explosion after 80 grenades detonated in Eastbourne

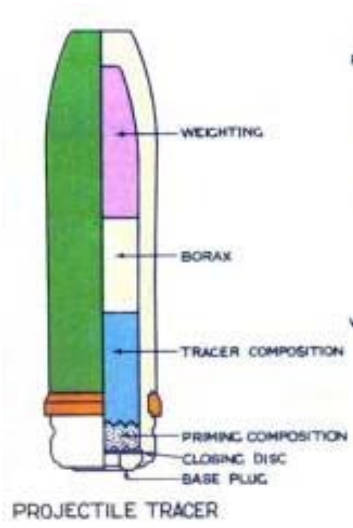
16:31 Monday 13 April 2015

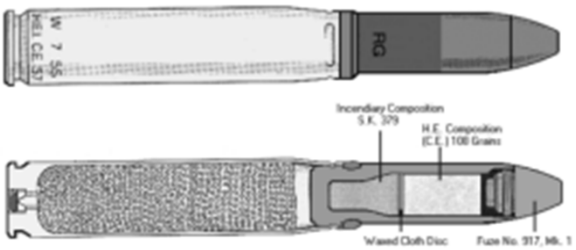
Marked 'AW Bomb 1940' the grenades were thought to have been phosphorus incendiary grenades created as improvised anti-tank weapons when Britain was facing invasion following the army's evacuation from Dunkirk in 1940.

He said, "I remember the grenades being buried. It was part of the Home Guard stash, it was put there in case we were invaded. It had to be in 1943. There were a lot of them [stashes], they were all over the place."

20mm Hispano HEI Ammunition

Type:	Live canon round
Markings:	Upper half of projectile painted 'buff' colour, lower half is red.
Cartridge Weight:	256 grams
Dimensions:	Total cartridge / projectile length - 182mm
Fuzed:	Contact fuze – No.253, No.254 or No.917
Filling:	108 grains of contact explosive + 68 grains of SR.379 incendiary composition.
Threat:	Explosives within unspent cartridge as well as the projectile.
Deployment:	Royal Navy, RAF and British Army Light Anti-Aircraft guns. Also RAF aircraft canons.
Remarks:	Cartridges are belted or supplied lose in cartons.

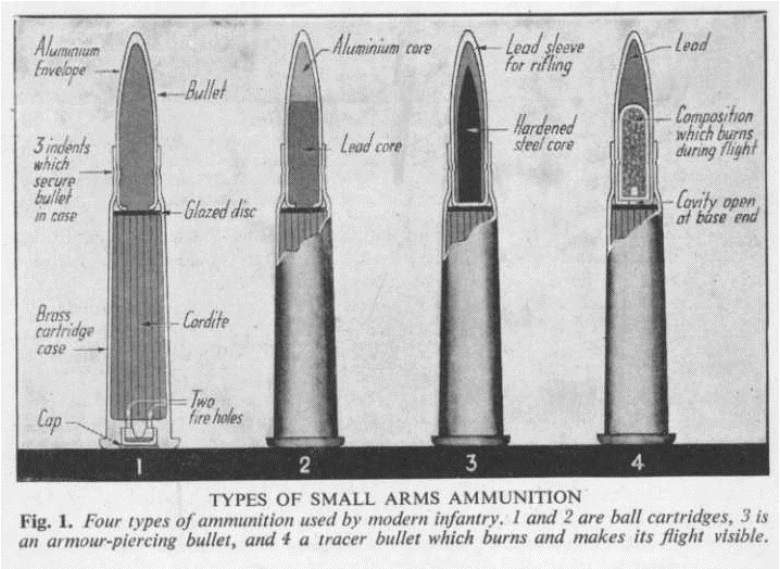




COLOUR IDENTIFICATION		
BRITISH		
NATURE OF SHELL	H.E.FILLING	COLOUR
H.E. TRACER	T.N.T.	
H.E.	T.N.T.	
PROJ. PRACTICE		
PROJ. TRACER		
H.E. INCENDIARY	T.N.T.	
H.E.INCENDIARY TRACER	T.N.T.	

.303" Ammunition

Type:	Rifle / machine gun round
Markings:	Regular round - none. Tracer round – red Primer
Bullet Weight:	150 - 180 grams
Dimensions:	Total cartridge /projectile length - 78mm
Filling:	Regular round – none. Tracer round - small incendiary fill
Threat:	Explosive cordite within unspent cartridge
Deployment:	Royal Navy, RAF and British Army Light Anti-Aircraft guns, machine guns and rifles. Standard British and Commonwealth military cartridge from 1889 until the 1950s.
Remarks:	Cartridges are belted or supplied lose in cartons.

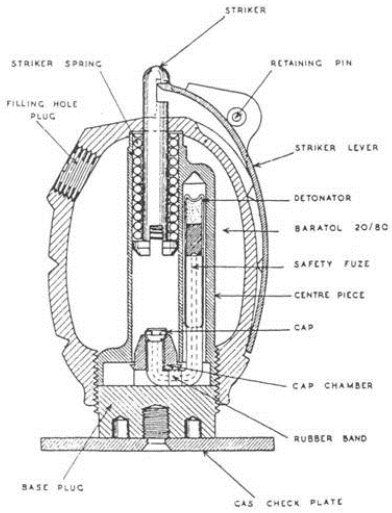


TYPES OF SMALL ARMS AMMUNITION

Fig. 1. *Four types of ammunition used by modern infantry. 1 and 2 are ball cartridges, 3 is an armour-piercing bullet, and 4 a tracer bullet which burns and makes its flight visible.*

No. 36 'Mills' Grenade

Weight:	0.7kg filled (1lb 6oz)
Type:	Hand or discharger, fragmentation
Dimensions:	95 x 61mm (3.7 x 2.4in)
Filling:	Alumatol, Amatol 2 or TNT
Remarks:	4 second hand-throwing fuse with approximate 30m range. First introduced May 1918.



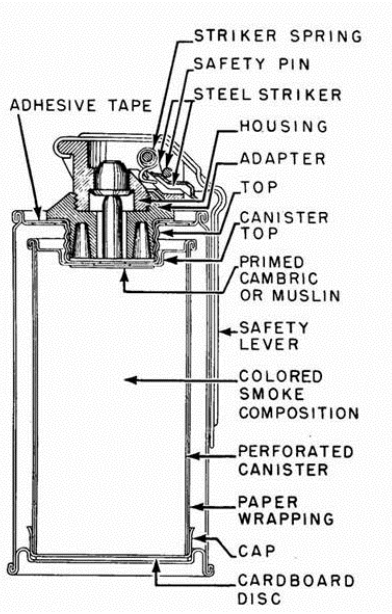
Grenade, .303 inch rifle, No. 36M, Mark I.

No. 69 Grenade

Weight:	0.38kg filled (0.8lb)
Type:	Percussion/Blast
Date Introduced:	December 1940
Remarks:	Black Bakelite body. Blast rather than fragmentation type. After unscrewing the safety cap, a tape is held when throwing the grenade releasing the safety bolt in the throwing motion. Detection is problematic due to its very low metal content.

Typical Smoke Grenade

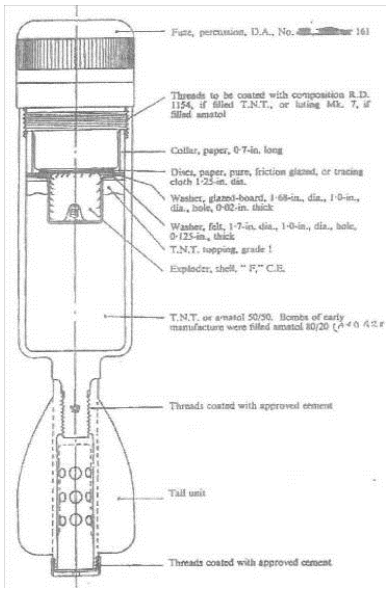
Dimensions:	Approx. 65 x 115mm (2.5 x 4.5in)
Type:	Smoke
Date Introduced:	Current MoD issue
Remarks:	Smoke grenades are used as ground-to-ground or ground-to-air signalling devices, target or landing zone marking devices, and screening devices for unit movement.



Source: Dynasafe BACTEC Limited and various historical sources

Typical 2 inch High Explosive Mortar

Bomb Weight: 1.02kg (2.25lb)
Type: High Explosive
Dimensions: 51 x 290mm (2in x 11.4in)
Filling: 200g RDX/TNT
Maximum Range: 457m (500yds)
Remarks: Fitted with an impact fuze which detonates the fuze booster charge (exploder) and, in turn, the high explosive charge. The main charge shatters the mortar bomb body, producing near optimum fragmentation and blast effect at the target.

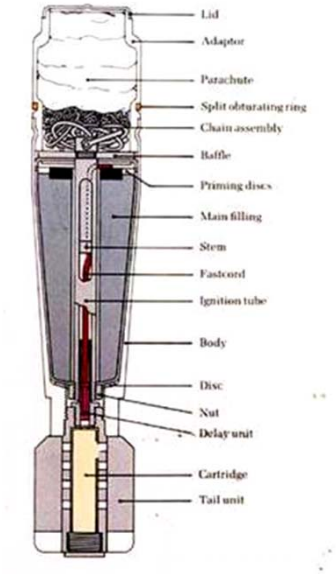


Typical 3 inch Smoke Mortar

Type: Smoke
Dimensions: c490 x 76mm (19.3in x 3in)
Filling: Typically white phosphorous
Maximum Range: 2515m (2,750yds)
Remarks: On impact, the fuze functions and initiates the bursting charge. The bursting charge ruptures the mortar bomb body and disperses the white phosphorous filler. The white phosphorous produces smoke upon exposure to the air.

Typical 2 inch Illuminating Mortar

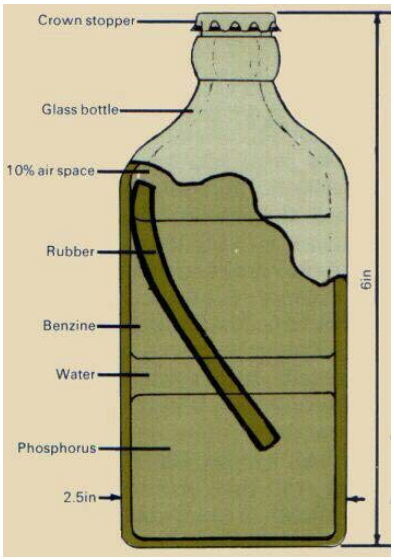
Type: Illum.
Dimensions: 51 x 290mm
Filling: Various
Remarks: The expulsion charge ignites and ejects the candle assembly. A spring ejects the parachute from the tail cone. The parachute opens, slowing the descent of the burning candle which illuminates the target.



Self Igniting Phosphorous (SIP) Grenades

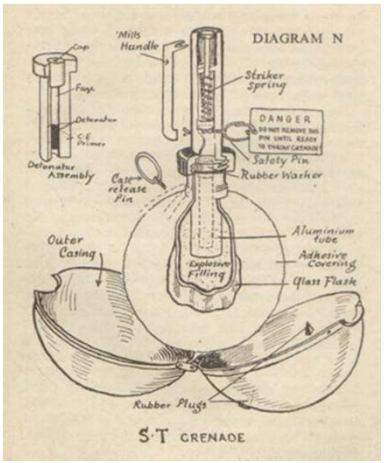
Filling: White Phosphorous and Benzene

Remarks: The grenade comprised a glass bottle with a total volume of approximately one pint. It was filled with White Phosphorus, benzene, a piece of rubber and water. Over time the rubber dissolved to create a sticky fluid which would self ignite when the bottle broke. Fired by hand or Northover Projector. Sometimes called the “A & W” (Albright & Wilson) grenade.



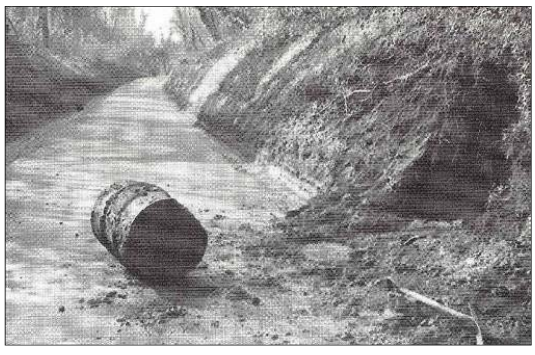
No 74 Grenade (Sticky Bomb)

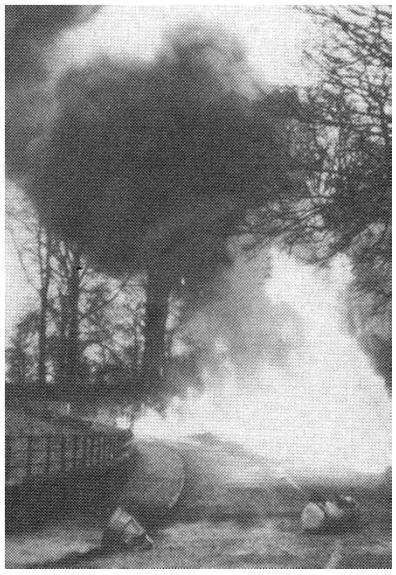
Remarks: Designed as an anti-tank grenade and used by the Home Guard. The grenade consisted of a glass ball on the end of a Bakelite (plastic) handle. Inside the glass ball was an explosive filling whilst on the outside was a very sticky adhesive covering. Until used, this adhesive covering was encased in a metal outer casing.



Flame Fougasse Bomb

Remarks: A Flame Fougasse was a weapon in which the projectile was a flammable liquid, typically a mixture of petrol and oil. It was usually constructed from a 40-gallon drum dug into the roadside and camouflaged. Ammonal provided the propellant charge which, when triggered, caused the weapon to shoot a flame 3m (10ft) wide and 27m (30 yards) long. Initially a mixture of 40% petrol and 60% gas oil was used, this was later replaced by an adhesive gel of tar, lime and petrol known as 5B.





Source: BACTEC International Limited and various historical sources

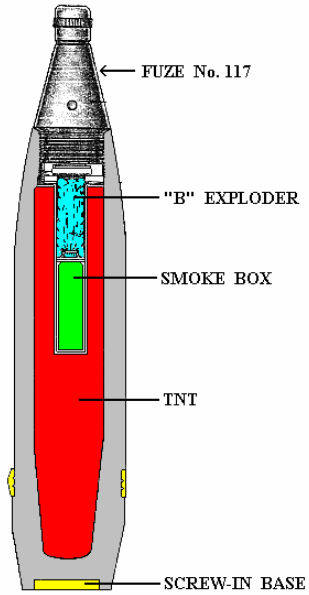
High Explosive Projectile: Fragmentation and Blast

Recognition Features

a) Long, pointed ogival nose and streamlined body.
b) Square or tapered base. Boat tailed/streamlined.
c) One-piece body construction.
d) Base plate screwed or welded to the base, occasionally of one piece construction.
e) Copper driving band near the base of the projectile.
f) Body construction normally thin.
g) Low charge to weight ratio.
h) Fuzed with point-initiating and/or base-detonating fuze.
i) If no driving band is present, it may use two bourrelets.

4in HE Projectile

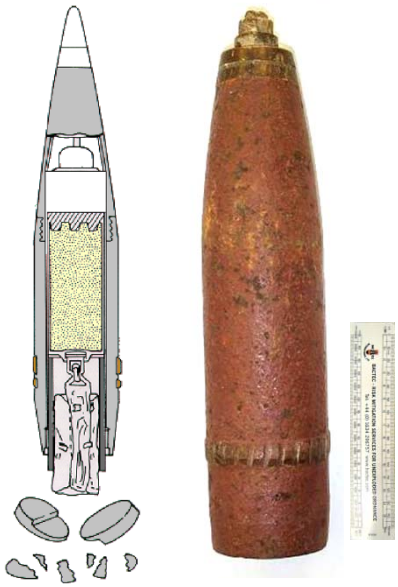
2in HE Projectile

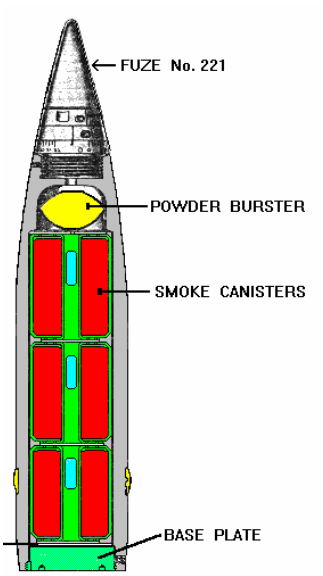


Carrier Projectiles: Base Ejection

Recognition Features

a) Ogival streamlined nose.
b) Nose/Time fuzed.
c) Parallel sides (on older items).
d) Square or tapered base.
e) One or two-piece body construction.
f) Base plate held in place by weakened PVC ring or shear pins.
g) Copper driving band may be fitted.
h) Base plate ejected if the munition has functioned.
i) Contains a small low explosive burster/expulsion charge.



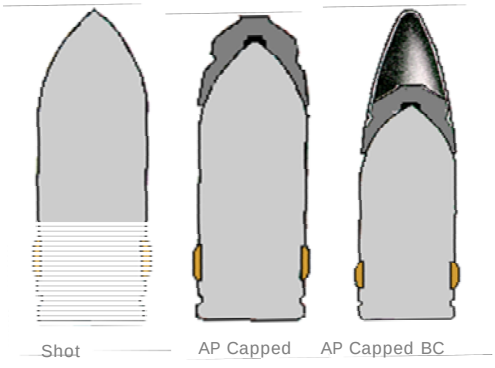


Shot Projectiles

Recognition Features

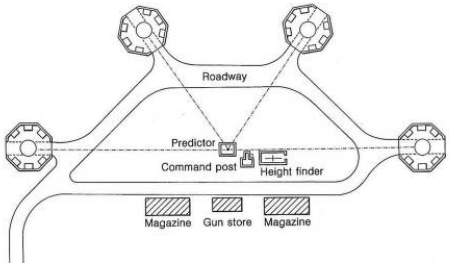
a) Driving bands (early designs) or obturators (current designs).
b) Tracer pockets common.
c) Ballistic caps and piercing caps (current designs).
d) Early shot projectiles were made of hard high grade steel. Current designs use tungsten carbide or Depleted Uranium (DU) cores or penetrators.
e) Most current shot projectiles now use discarding sabots, either of the post or petal type
f) Proof shot projectiles have flat heads and are used to test guns.
g) No fuzes are present.

4in Solid Shot



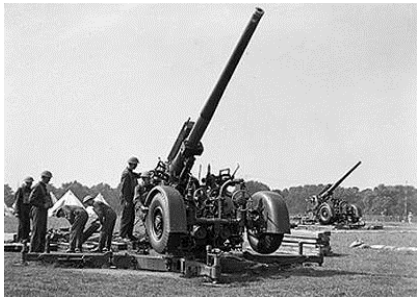
3.7 inch Anti-Aircraft Projectile

Weight:	12.7kg (28lb)
Dimensions:	94 x 360mm (3.7 x 14.7in)
Carriage:	Mobile and Static Versions
Rate of Fire:	10-20 rounds per minute
Ceiling:	9-18,000m (29-59,000ft)
Muzzle Velocity:	792m/s (2,598ft/s)
Remarks:	4.5 inch projectiles were also commonly utilised



Layout plan for a typical HAA battery site.

This AA shell was uncovered on a construction site in North London in February 2009.

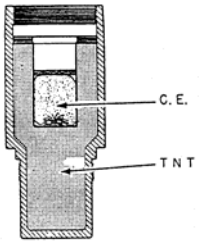


Hyde Park 1939 3.7 Inch QF gun on mobile mounting

3.7 inch AA Projectile Minus Fuze

Rockets / Unrotated Projectiles

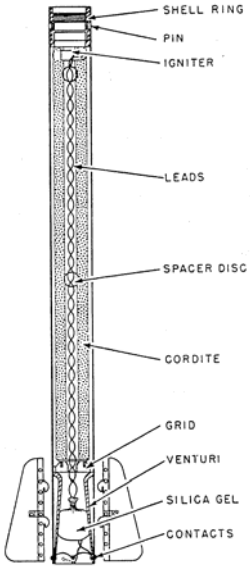
Weight:	Overall: 24.5kg (54lb) Warhead: 1.94kg (4.28lb)
Dimensions:	1930mm x 82.6mm (76 x 3.25in)
Carriage:	Mobile – transported on trailers
Ceiling:	6770m (22,200ft)
Maximum Velocity:	457mps (1,500 fps)



MK II HE Shell (3.5kg)

Rocket Battery in action

Home Guard soldiers load an anti-aircraft rocket at a 'Z' Battery



2" U.P AA Rocket

40mm Bofors Gun Projectile

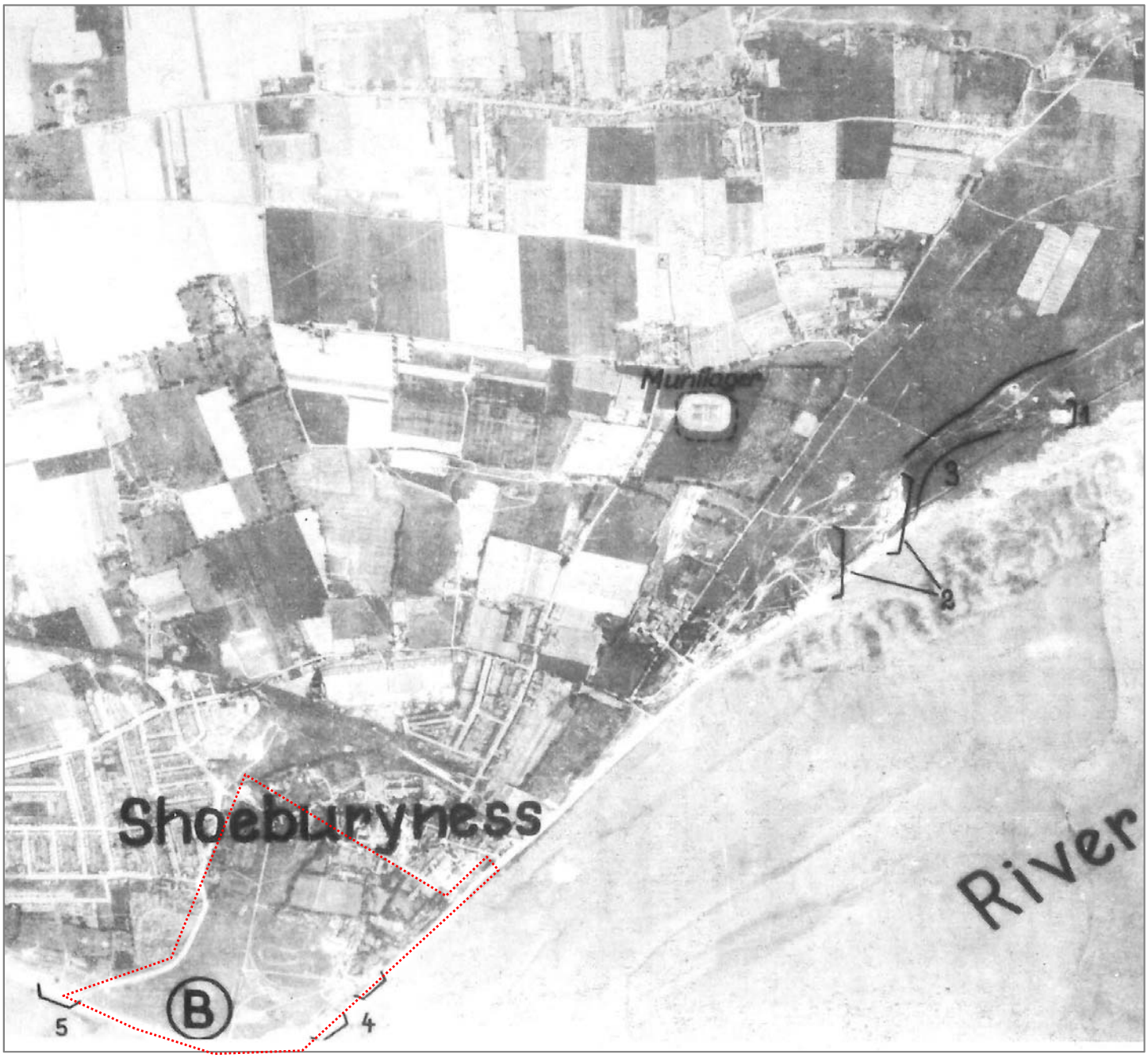
Weight:	0.86kg (1.96lb)
Dimensions:	40mm x 310mm (1.6in x 12.2in)
Rate of Fire:	120 rounds per minute
Ceiling:	23,000ft (7000m)
Muzzle Velocity:	2,890 ft/s (881m/s)
Remarks:	Mobile batteries – normally few records of where these guns were located

Unexploded 40mm Bofors projectile recovered from a marine environment

40mm Bofors gun and crew at Stanmore in Middlesex, 28 June 1940.

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: Dynasafe BACTEC Limited and various historical sources

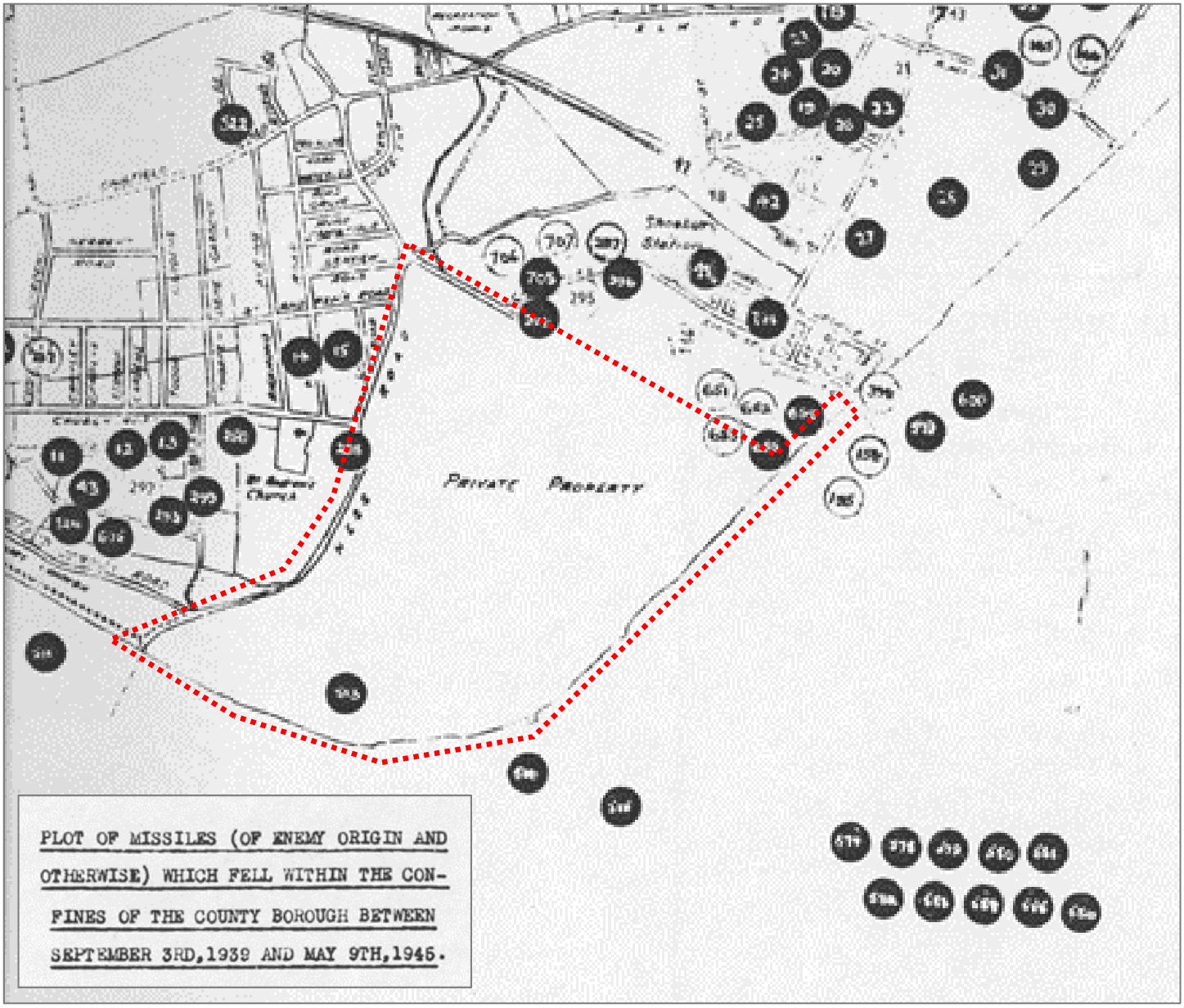


General site location

Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: N. J. Clarke, 1996

North



KEY

H.E. Bombs, A.P. Bombs, A.A. Shells.	Exploded.
H.E. Bombs, A.P. Bombs, A.A. Shells.	Unexploded.
Distribution of A.P. Bombs from Containers (A.B.23 S.D.2.) each holding 23 Bombs.	
Incendiary Bombs (of all types)	Exploded & Unexploded.
Distribution of I.B.'s in loads in excess of 100 Bombs.	

General site location

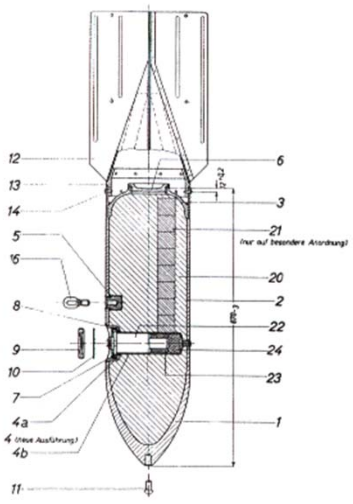
Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	
Source: Essex Record Office		

SC 50

Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	c25kg (55lb)
Fuze Type:	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions:	1,090 x 280mm (42.9 x 11.0in)
Body Diameter:	200mm (7.87in)
Use:	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks:	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.

50kg bomb, London Docklands

Minus tail section

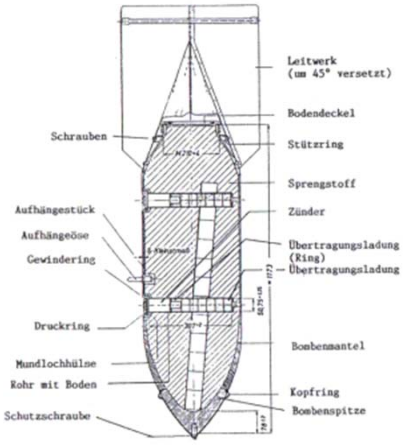


SC-50 JA (Güteklasse 1)

SC 250

Bomb weight:	245-256kg (540-564lb)
Explosive weight:	125-130kg (276-287lb)
Fuze type:	Electrical impact/mechanical time delay fuze.
Bomb dimensions:	1640 x 512mm (64.57 x 20.16in)
Body diameter:	368mm (14.5in)
Use:	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.

250kg bomb, Hawkinge

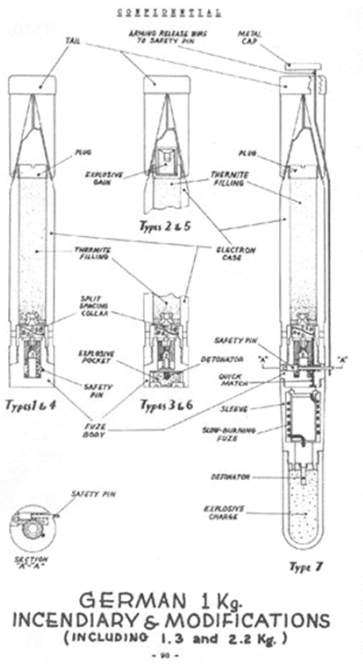


SC-250 JA (Güteklasse I)

1kg Incendiary Bomb

Bomb weight:	1.0 and 1.3kg (2.2 and 2.87lb)
Filling:	680gm (1.3lb) Thermite
Fuze type:	Impact fuze
Bomb dimensions:	350 x 50mm (13.8 x 1.97in)
Body diameter:	50mm (1.97in)
Use:	As incendiary – dropped in clusters against towns and industrial complexes
Remarks:	Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes fitted with high explosive charge

1. Scaffold pipe
2. Incendiary 1kg bomb
3. Incendiary bomb recently found on site in UK



GERMAN 1 Kg. INCENDIARY & MODIFICATIONS (INCLUDING 1.3 and 2.2 Kg.)

The Telegraph

11:50AM GMT 24 Mar 2015

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Giant WWII bomb dug up by builders in London

A massive evacuation procedure is carried out in Bermondsey, south London, after the 1,000lb explosive measuring 5ft long was uncovered

Express & Echo

6.1 °C Light Rain Shower

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Road closed after German bomb found in Axminster garden

By Exeter Express and Echo | Posted: June 03, 2014

A major road in Axminster has been closed after an air-dropped German bomb was found in a garden.

Mother-of-two digs up unexploded WWII bomb in garden and casually flings it on the rubbish thinking it was an old exhaust pipe

- Carole Fisher-White, 56, unearthed a mortar shell in her back garden
- It was only when sons said it looked like a bomb that the penny dropped
- Royal Navy bomb disposal team called to defuse the device
- The 29mm Spigot Mortar was was an infantry anti-tank weapon
- Also known as the Blacker Bombard it was used by the Home Guard

Page last updated at 14:45 GMT, Friday, 22 May 2009 15:45 UK

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Building site WWII bomb exploded

00:20 / 00:28 SHARE

Building site WWII bomb exploded

A controlled explosion has been carried out on a World War II bomb found on a building site in East Sussex.

The 110lb (50kg) SC50 bomb, thought to have been dropped from a German aircraft in 1940 or 1941, was found at the Hollenden House

Unexploded Second World War grenade discovered by a curious dog

2008, 27 March 2013 | By Charlotte Cox

Police and Army bomb disposal experts were called to the address in Peakdale Avenue, Heald Green.

A dog called Snoop has sniffed out a suspected Second World War grenade in a Stockport garden.

Police and Army bomb disposal experts were called to the address in Peakdale Avenue, Heald Green.

The took the grenade to nearby parkland and destroyed in a controlled explosion.

Page last updated at 14:23 GMT, Thursday, 5 June 2008 15:23 UK

BBC

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Unexploded bomb 'started to tick'

An unexploded World War II bomb started to tick and ooze liquid as experts tried to defuse it, police have said.

The large bomb was found in a river at Sugar House Lane, near Bromley-by-Bow Tube station in east London, on Monday.

Rush-hour travel was disrupted as overnight work to make the bomb safe continued into Thursday morning.

"It measures approximately the size and length of a man, and weighs around 1,000kg (2,200lb).

Royal Navy clearance divers dispose of 70-year old German bomb

Posted on August 8, 2013

The team of four from the Southern Diving Unit 1 at HM Naval Base Devonport, Plymouth, blew up the air-dropped bomb in-situ in a controlled explosion where it was found by contractors for SW Water laying a mains in a field at St Eval Kart Circuit near Wadebridge, north Cornwall yesterday.

1994

Blown up by history

RESCUE workers search for survivors after a Second World War bomb exploded at a building site in Berlin, killing three people and injuring at least eight others.

A fire brigade spokesman said he feared the final death toll could be higher. One worker was still missing, believed to be trapped under a machine. "We've found human remains 100 metres away but we can't tell if they belong to the dead already found," the spokesman said.

The blast, set off by drilling work on Frankfurter Allee, one of east Berlin's busiest avenues, trapped workers under building machinery and sent huge chunks of concrete tumbling through the air.

A large office block was being built on the site of the explosion which sent shoppers scrambling for shelter and paralysed dense afternoon traffic. One eyewitness said: "There was a bang, then silence, and then it started raining stones and dirt."

Dozens of cars within a 250-metre radius were wrecked and the top two floors of a nearby apartment block caved in.

Radio reports claimed that the total number of injured stood at 14.

2008

2006

World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.

Unexploded WWII bombs dropped by Allied planes are frequently found in Germany, though it is unusual for them to explode unexpectedly.

2010

The bomb went off as the machine lifted up earth and debris

A World War Two bomb has exploded at a construction site near a west German town, killing a man and injuring eight others, police say.

The explosion occurred after a digger accidentally struck the device during excavation work in Euskirchen in the state of North Rhine-Westphalia.

The machine's operator died on the spot. Two of those hurt were critically wounded, the dpa news agency reports.

Related

2014

2006

Top Left: WWII bomb killed 3, injured 8 (Berlin – 1994)
Middle Left: WWII bomb killed 3 in Goettingen, Germany – 2010.
Bottom Left: Excavator operator killed by WWII bomb in Euskirchen, Germany – 2014.
Top Right: WWII bomb injures 17 at construction site in Hattingen, Germany - 2008.
Middle Right: A highway construction worker in Germany accidentally struck a WWII bomb, killing himself and wrecking several passing cars - 2006.
Bottom Right: Destroyed piling rig and dump truck after detonation of WWII UXB (buried at 12m bgl) in Austria - 2006.

North

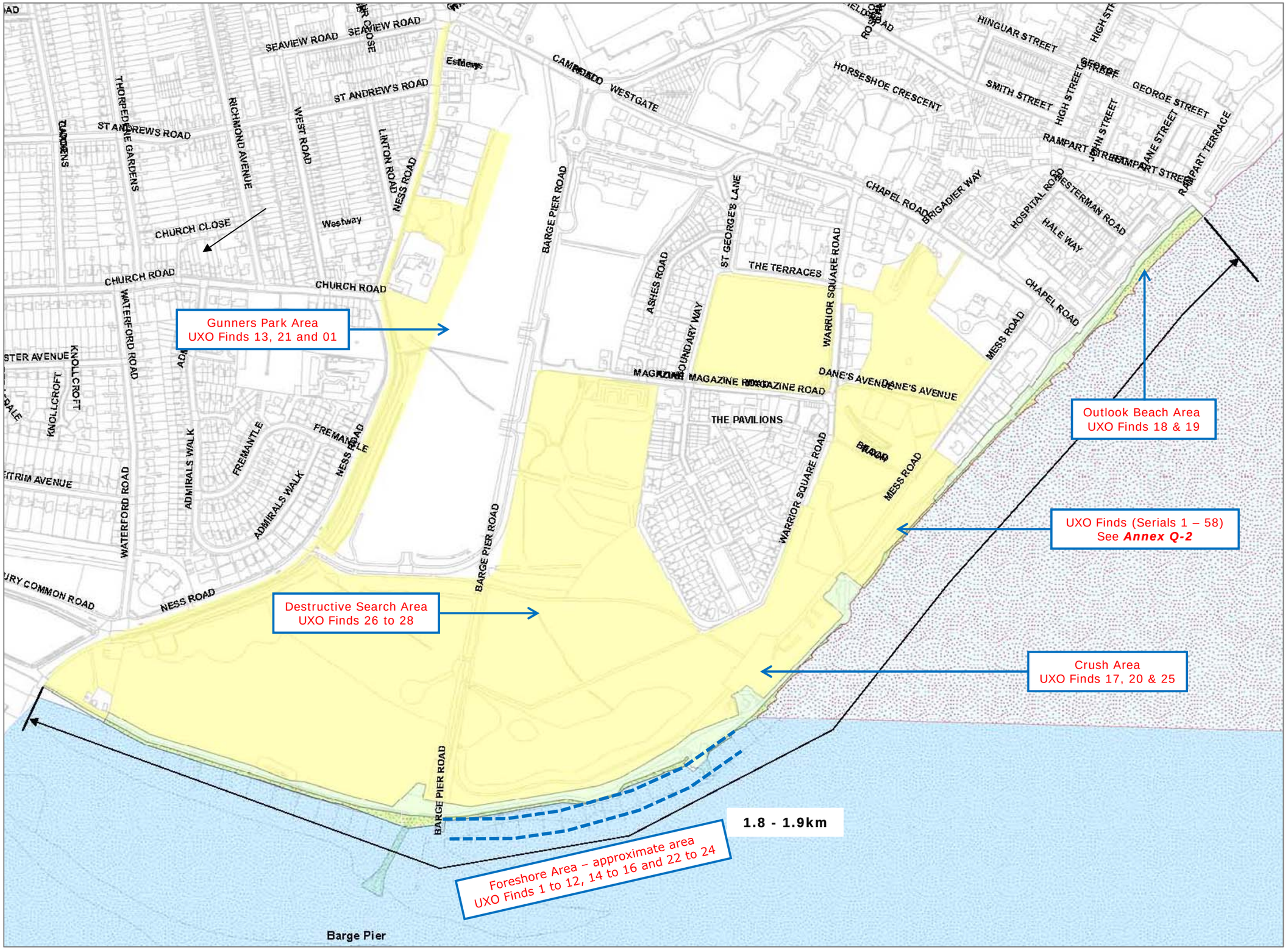
Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: Dynasafe BACTEC Limited and various historical sources

Above: A pile of projectiles recovered during the 1973 clearance task

Below: Discarded bombs and torpedoes from this clearance task still litter the coastal areas of the range

North



Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Dynasafe BACTEC Limited		

Partial view of work site

Groynes with locations of some finds

Serial 9 – Live Palliser Shell as found

Serial 35 – Cannon Ball

Serials 36 & 37 – Fragmentation & Armstrong Shells

Serial 58 – Live Hodgkiss Shell

Serial 43 - Unidentified item

Serial 9 – Live Palliser Shell

Serial 8 – Inert 3" Mortar

Serial 28 – Inert Solid Shot, as found

Serial 17 – Live 15lb Naval Shell

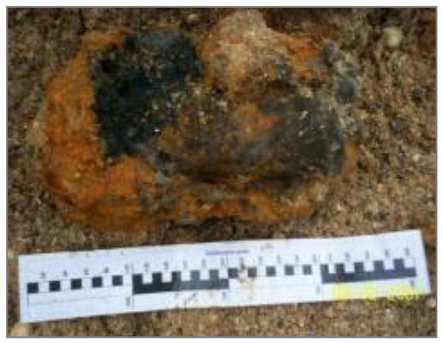
Serials 71 to 75 - Shell, Fuzes, Gains

Serial 31 – Suspect White Phosphorus Shell

Serials 39 to 56 – Fuzes and Gains

Serial 28 – Inert Solid Shot

Serial 51 – Unidentified



Serial 33 – Live Armstrong Shell

Serial 33 – Live Armstrong Shell

Find 1 - 23 Type 101 fuzes (inert)

Find 4 – Live 15lb fragmentation shell

Finds 2 & 3 – Live high explosive shells

Find 13 – Live Armstong Shells

Find 26 – Live Armstrong Shell

Find 5 – Live 15lb fragmentation shell

Find 6 - 15lb Fragmentation Shell

Find 26 – Live Armstrong Shell

Find 28 – Live Smoke Shell

Mortar Fuze

Find 1

Find 71 to 75 - Shell, Fuzes, Gains

Find 20 – low explosive gain

Find 25 – Cannon balls

Find 24 – Hodgkiss round

Find 18 - 25lb Armstrong Projectile

Find 27 – Live Armstrong Shell

25lb Armstrong Projectile

Report Reference: 6180TA Rev-3	Client: Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site	
Source: Dynasafe BACTEC Limited		

North

Low Risk Zone

Cricket Pitch

The site of a historical cricket pitch, present since the establishment of the Old Ranges

Low - Medium Risk Zone

Parkland

Area of historical open ground / recreation space away from the weapons ranges

Other areas not within the scope of this assessment

Note, previous UXO Clearance has been carried out in those areas subject to recent redevelopment

High Risk Zone

Parkland

Other land within Council responsibility – Area of historical weapons ranges

High Risk Zone

Beach / Foreshore

Tidal currents / wave action have resulted in additional items of UXO being washed up on the beaches / foreshore

Recommended Mitigation Measures

All Risk Zones

- Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works
- The Provision of Unexploded Ordnance Site Safety Instructions

Low - Medium and High Risk Zones only

- Explosive Ordnance Disposal (EOD) Engineer presence on site to support any future open excavations
- Explosive Ordnance Sifter Deployed to Clear Beach Sediments

Report Reference:	Client:	
6180TA Rev-3	Southend-on-Sea Borough Council	DYNASAFE
	Project: MoD Beach & Park Garrison Site, Shoeburyness	

Source: Dynasafe BACTEC Limited