

Unexploded Ordnance (UXO) Risk Assessment

Project: Tata Steelworks

Project address: Port Talbot, SA13 2NG

Client: Sir Robert McAlpine Ltd

Report revision: 2

Report date: 23rd April 2025



COMMERCIAL-IN-CONFIDENCE

This risk assessment has been produced by Bombs Away Ltd for Sir Robert McAlpine Ltd. It has been provided solely for the purpose of assessment and evaluation of UXO risk for the specified project, geographical area and construction processes described herein. It should not be used for any purpose other than that specified or by anyone other than the client. Any liability arising out of third-party use of this document, shall be the responsibility of that party, who shall indemnify Bombs Away Ltd against all claims, costs, damages and losses arising out of such use.

Bombs Away Ltd	124 City Road, London EC1V 2NX
Email	Office@BombsAway.Ltd
Web	www.BombsAwayUXO.com
Phone	0871 268 4400
Company registration	11054420
VAT registration	GB 285 0961 78

Revision record

Rev	Author	Checked by	Issue date	Notes
0	N Cross	M Owen	26 th Mar 25	Initial draft
1	N Cross	M Owen	28 th Mar 25	Initial review, for issue to SRM
2	P Smith	M Owen	23 rd Apr 25	Updated following SRM comments
3				Not currently used

Distribution record

Copy	Format	Recipient	Notes
1	PDF	Sir Robert McAlpine Ltd	Client
2	PDF	Bombs Away Ltd	
3	n/a	n/a	Not currently used
4	n/a	n/a	Not currently used

About Bombs Away Ltd

Bombs Away Ltd was formed by Marc Owen BSc MBA FCIOB MInstRE TIEpE. He is a former commissioned officer in the Royal Engineers with 20 years of subsequent experience working in the construction industry.

He is a subject matter expert regarding UXO on construction sites and was a key member of the steering group for the Construction Industry Research and Information Association's latest guidance on UXO, lecturing for them several times. He undertook ground-breaking research published by the Institution of Civil Engineers, to establish the probability of discovering unexploded bombs on building sites and has been interviewed on the national news in response to the discovery of unexploded ordnance.

Bombs Away Ltd is unlike any other UXO risk assessment consultancy because we:

- specialise in providing a project specific assessment that gives a realistic indication of discovering UXO,
- provide risk assessments for the benefit of the construction industry, not the UXO clearance industry,
- are independent of every UXO clearance contractor,
- do not offer site-based investigation services,
- will not recommend unnecessary mitigation measures.

Contents

Section 1. Executive Summary	4
Section 2. Introduction.....	4
Section 3. Review of original risk assessment.....	8
Section 3.1 Summary of findings in original risk assessment	9
Section 3.2 Detailed review of risk assessment	10
Section 4. Summary of findings from the review and recommendations	31
Section 5. References and bibliography.....	32

Section 1. Executive Summary

A detailed unexploded ordnance (UXO) risk assessment was completed by RSK Ordnance Management in May 2024, for the Tata Steelworks site in Port Talbot. Their assessment deemed the “*risk of encounter*” for the site to be “*moderate*” and the “*risk of harm*” to be “*severe*”.

This report is an updated assessment of the risk, using their report but has considered additional lines of evidence available to assess the risk for the completion of construction works (scope detailed later) and as a result, the assessed risk of harm from UXO during those works has been reduced.

It is the opinion of Bombs Away Ltd that the most significant UXO hazard is posed by WW2 German high explosive (HE) bombs owing to the potential for harm, and we estimate that the probability of such a weapon remaining on the site is about 1 in 137. The probability of actually *encountering* such a weapon during the main site works is estimated to be about 1 in 1,175.

For the purpose of complying with the Health and Safety at Work Act (1974), Bombs Away Ltd do not consider it appropriate or necessary for UXO site surveys to be completed, nor to employ a specialist UXO banksman to undertake a watching brief. The client may still consider the implementation of mitigation measures to be appropriate if the unexpected discovery of UXO (or suspected UXO) may cause an unacceptable delay to the project or disruption to other services for which the client may be held responsible.

An emergency plan detailing actions to be taken if UXO is discovered should be developed. It is considered appropriate that any person who is working in the ground (for example site investigation surveyors, piling contractors, groundwork contractors and similar) should undertake a UXO briefing as part of their initial site induction and for toolbox talks to be completed.

A template for the emergency response plan and a toolbox talk can be downloaded for free from the “downloads” page at www.BombsAwayUXO.com

Project insurance should also cover ‘acts of war’ in relation to the discovery and subsequent destruction of unexploded ordnance in-situ.

Section 2. Introduction

The Health and Safety at Work Act, 1974, requires steps to be taken to reduce risks, so far as is reasonably practicable. This means balancing the level of risk against the measures needed to control the real risk; it is not necessary to take action if it would be grossly disproportionate to the level of risk.

Regulation 3 of the Management of Health and Safety at Work Regulations 1999 creates the legal requirement to complete risk assessments. Guidance is provided by the Construction Industry Research and Information Association (CIRIA) publication C681, "Unexploded ordnance (UXO), a guide for the construction industry".

CIRIA propose a four-stage process:

- Stage 1 - Preliminary risk assessment. The purpose of the initial risk assessment is to place a site in a historical context to assess potential risk from UXO and to identify whether a more detailed assessment is required.
- Stage 2 – detailed risk assessment. If recommended as part of the preliminary (stage 1) risk assessment, a detailed risk assessment will be completed to estimate the hazard of UXO on a site and the probability of encountering it, giving due consideration to the construction methods that will be employed.
- Stage 3 – risk mitigation. This stage of the process would identify how to reduce risk to an acceptable level, as it is not possible to eliminate the risk of UXO.
- Stage 4 – implementation. During this final stage, the appropriate risk mitigation plan (if any) would be implemented.

All parties must be fully aware that industry guidance for UXO on construction sites (CIRIA C681) accepts that there will be a risk of UXO remaining on a site. The guide states that "no current UXO detection survey technology can provide complete assurance that every buried UXO item has been detected, located and removed. Even the most reasonably practicable method, other than shifting all the soils beneath a site will leave some level of residual risk." Even when a clearance certificate has been provided, it does "not constitute a guarantee that the site is clear of UXO".

This assessment does not consider the client's attitude to *commercial risk*. The client may still consider undertaking intrusive UXO surveys if they feel that the unexpected discovery of UXO (or suspected UXO) may cause an unacceptable delay to the project, cause reputational damage, or cause disruption to other services for which the client may be held responsible.

On several occasions, the Ministry of Defence have permitted the destruction of WW2 air dropped weapons by military bomb disposal teams *in-situ*, within built up areas, without attempting to remove the weapon's explosive. This increases the risk of damage to adjacent property and the liability for such an event may lie with private insurers, as the Government have refused to accept responsibility for the damage. In the unlikely event that an unexploded bomb is found, it is essential that there is appropriate insurance to cover this eventuality with no exclusion as part of an 'act of war' clause.

Section 2.1 Scope and limitations

This report is based on the information contained within the Detailed UXO Risk Assessment produced by RSK Ordnance Management, dated 29th May 2024, report number S2RA-1004. Additional information has been researched and recorded in this review.

Section 2.2 Proposed construction works

Development works are described in a planning application submitted to Neath Port Talbot Council in November 2024, referenced P2024/0711. This is for the demolition of existing buildings, partial infill of the BOS lagoon, construction of a new electric arc furnace facility and associated infrastructure, landscaping etc.

Section 2.3 Drawing of the existing site & risk assessment boundary (in red)

A plan of the site prior to redevelopment is included below.

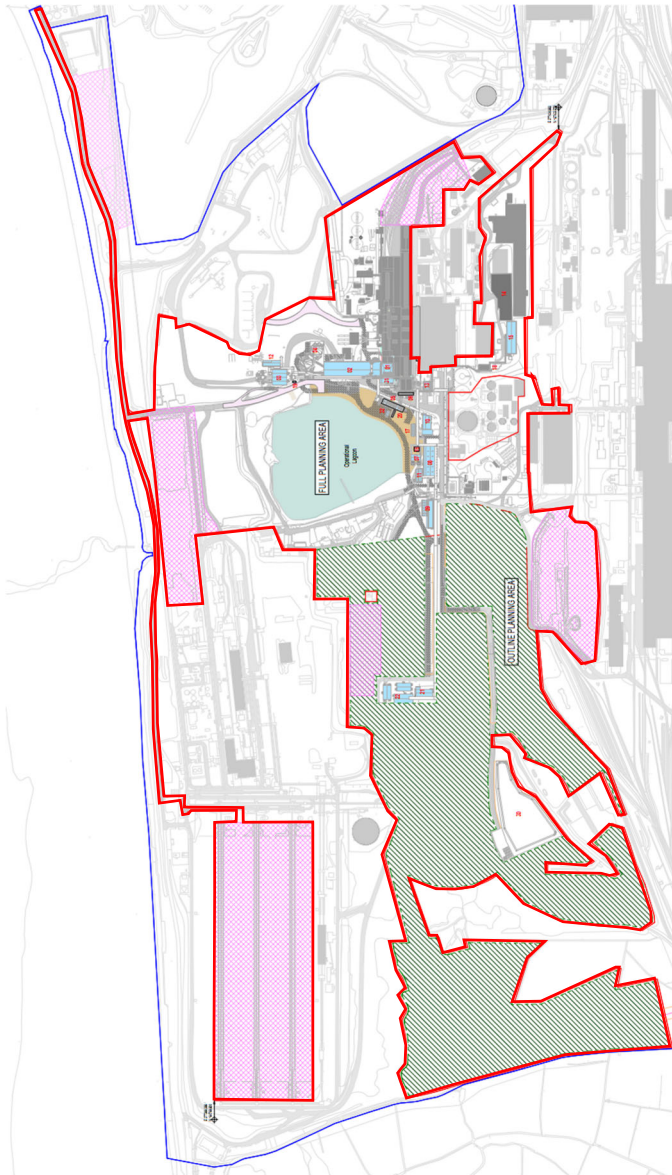


The red line in this drawing has been reproduced from the boundary described in the planning application specified above. This is slightly larger than the area considered by RSK. The additional areas assessed in this report have been shaded green.

The outer blue line indicates the extent of land in the client's control.

Section 2.4 Proposed site plan

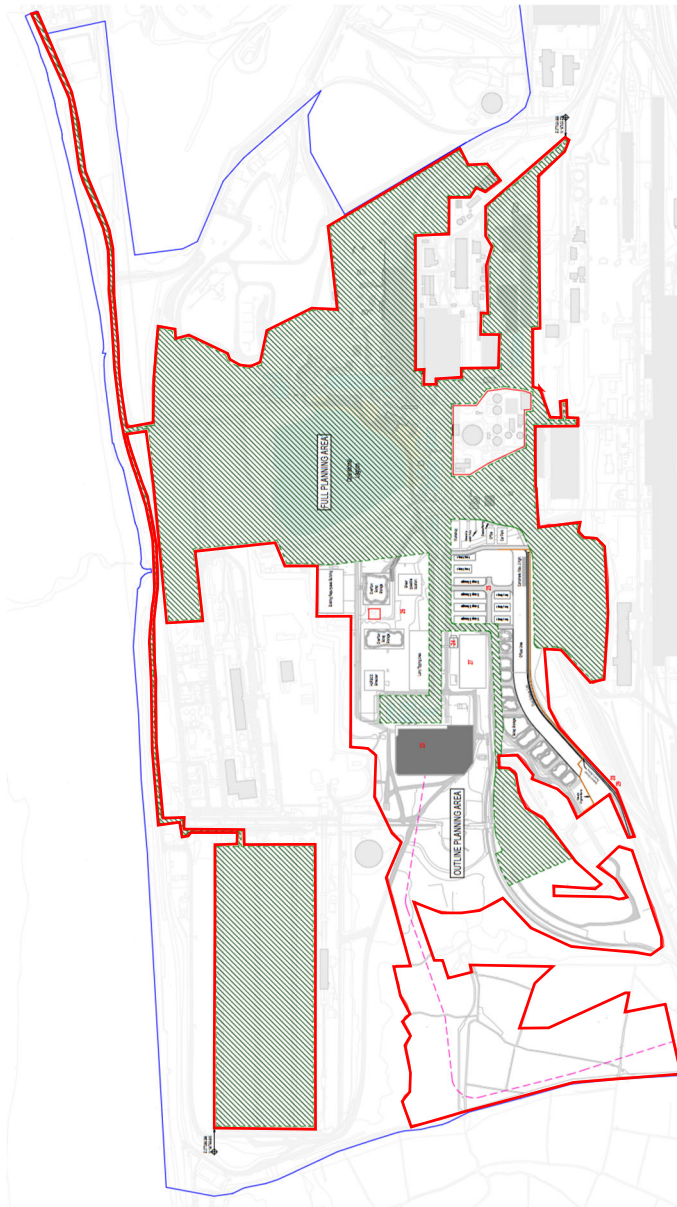
Drawings showing GAs of the proposed site plan by Lawray Architects follow. The first drawing (below) shows the initial phase of works, for which full planning consent has been obtained. The area covered by the green hatch shading has outline planning permission and will primarily be used for scrap metal handling.



The large majority of the proposed buildings (coloured light blue on the drawing) are within the 'full planning area'.

Proposed buildings within this area that have relatively large footprints include: the consteel conveyor, fume treatment plant, pump houses (3nr), power distribution/ electrical buildings (5nr), and a changing/ office building,

COMMERCIAL-IN-CONFIDENCE



This second drawing by Lawray Architects (left) shows detail within the outline planning area. The green hatch shading is now indicative of the zone which has achieved full planning consent.

This second area, which is generally to the south/east of the site, will be used for scrap metal processing and storage. Few new buildings are shown in this area, although proposed features include a National Grid compound, an electrical building, scanning facilities and a weighbridge.

Section 3. Review of risk

This section consists of our independent review of the original report's content. Where relevant, the page number of their report has been stated in brackets for ease of reference.

Section 3.1 Summary of findings in original risk assessment

The detailed UXO risk assessment report that has been reviewed (reference S2RA-1004, dated 29th May 2024) was prepared by RSK Ordnance Management (referred to as RSK in this report) for RSK Geosciences. It states that they believe there is *"an overall MODERATE RISK from items of German UXO, with a zone of MODERATE RISK from items of Allied UXO"* (p.i). They consider there to be *"an overall SEVERE risk of harm"*.

The key findings stated in the RSK report used to reach this conclusion are repeated verbatim below.

For German UXO:

- *During WWII, the site was situated within the Municipal Borough of Port Talbot. Identified targets were situated within 1km, while two bombing decoys were situated within the south of the site.*
- *Bombing incidents, possibly on site, occurred at Morfa beach and sidings; Morfa sidings were likely associated with Morfa colliery, on site at this point, while the western section of the site comprised a section of the beach.*
- *Post-WWII aerial photography indicates that the vast majority of the site comprised open, undeveloped ground at the time of WWII. Large sections of this ground cover comprised saltings and mudflats, within which a UXB strike would have left no evidence of its occurrence.*
- *The extensive post-WWII ground works will have mitigated a large degree of risk on site. These areas can be considered mitigated to the precise depths of previous post-WWII ground intrusions. Any intrusions beneath these depths would require active risk mitigation measures.*

British/Allied UXO:

- *During WWII, a local Auxiliary Unit are known to have trained on sand dunes in the local area, potentially adjacent to the site. A partially submerged tank is also located here, thought to have been used in D-Day exercises.*
- *A moving target range is located adjacent to the site; it is conceivable that LSA, as well as SAA, was expended here. RSK OM have accessed an open-source database recording anti-aircraft positions in Britain; this records 13 HAA batteries within a 15km radius of the site, one of which may have been located on Morfa Beach.*

COMMERCIAL-IN-CONFIDENCE

The recommended mitigation for all areas was:

- *UXO Safety Awareness Briefings for all areas*
- *UXO Watching Brief*
- *Intrusive Magnetometer Survey*

And in “risk zone 2” (the strip of land to the south-east of the site, identified as RZ2 on page ii of the RSK report) due to their opinion there is an increased risk due to Allied unexploded ordnance:

- *Non-Intrusive Magnetometer Survey*

Section 3.2 Detailed review of original risk assessment

Overview

Bombs Away agree with the factual data presented in the original report, however interpret some of the information differently, given the additional information that has been located.

It is our opinion that the risk posed by air dropped Luftwaffe bombs needs to be assessed further. Whilst RSK acknowledge the potential for harm from such a weapon, they do not assess the probability this type of bomb may remain on the site. This will be discussed later.

There does not appear to have been an attempt to identify whether aircraft crashed on the site, which is an additional potential source of contamination by Allied UXO.

The original report splits the “*risk of harm*” into three levels: tolerable, medium and severe (p.9). The define “*severe*” to mean the “*potential to cause fatalities*”. It is generally accepted that ‘risk’ is a function of both the probability that an event may occur and the potential severity posed a hazard. As such we will investigate this facet of the report further.

The original report makes reference to the role of the private sector UXO specialists (p.2), noting that reactive risk mitigation can be implemented and the “*type of support needed can be tailored to each construction project, considering factors such as the proposed works, number of ground intrusions, and how those ground intrusions are carried out*”. Our report will consider the construction processes that will occur on the project in more detail, as the original description of the construction activity is restricted to “*Site Investigation works are planned, comprising a series of boreholes to a maximum depth of 75m bgl, although most will only intrude to 30m bgl. Following these works, the site will be undergoing a large knock down and rebuild, most notably just north of the reservoir*” (pp. i&4).

COMMERCIAL-IN-CONFIDENCE

There are numerous comments that an event is “possible”, “could have occurred” or there is the “potential” for it to have happened. For example, they say the “Moderate UXO risk in the southernmost section means that an encounter with items of unexploded LSA is possible” (p.15). Whilst this is true, in this report, the **probability** will also be assessed and then related to the extent of mitigation required.

They claim that five factors are assessed to ensure that the recommended mitigation is “appropriate and proportionate” (p.3). These factors are:

- *The risk that the site became contaminated with unexploded ordnance.*
- *The risk that any such UXO remains on site.*
- *The risk that any such ordnance may be encountered during the proposed intrusive works.*
- *The risk that any such ordnance may be initiated during this process.*
- *The consequences of initiating or encountering any such ordnance.*

‘Risk’ is generally considered to be a function of both the probability that an event may occur and the potential severity posed a hazard. In the bullet points above, the word ‘risk’ is used, when ‘probability’ would be appropriate. RSK make a good assessment of the site’s history and have collated information from multiple sources (although Bombs Away do not concur with all of RSK’s conclusions), but additional research is needed to establish the probability the site was contaminated by UXO. We will undertake additional consideration of past construction works.

Reliably quantifying the probability that ordnance will be initiated during the construction process is very difficult, primarily because it is such a rare occurrence, so available data is very limited. It is known that the last confirmed fatality on a UK construction site due to initiating ordnance occurred in the 1940s. RSK’s final point relates to the consequences of initiating or encountering ordnance. Care must be taken to avoid conflating the potential health & safety risks, with commercial risk – most likely delay and disruption to the project. If the risk to health and safety is very low, a company is entitled to make a commercial decision that the cost and time associated with implementing mitigation is not reasonable.

These assessments are then consolidated into the “risk rating”, but additional consideration to link between this assessment process and the allocation of the risk rating is required.

We do not accept some assertions in the original assessment, such as the implication that unexploded German air-dropped weapons can spontaneously initiate (that is detonate) without interference (p.9). Whilst Allied air dropped bombs are relatively unstable and there are a very small number of instances when they exploded many years after delivery (eg Germany in 2019 and Japan in 2024), German bombs used a different fuzing system and were much more reliable.

COMMERCIAL-IN-CONFIDENCE

When discussing the fuzes used by the Luftwaffe, they continue to say that the *“prevailing thinking is that if the clockwork fuze malfunctioned at the time of use, it is unlikely to be initiated again. However, this has been known to happen, and the reader should be aware of this possibility”*. A German clockwork timer restarting is an incredibly unusual event, which last occurred in the UK over 20 years ago and did not result in the bomb detonating, most likely because, as RSK acknowledge, *“unexploded ordnance, like most other buried objects, degrade over time.”*

RSK correctly note that an *“empty shell was found to the north of the site in 2020”* (p.10) during construction works. Whilst this item did not contain explosive or pose a risk, considerable disruption resulted following its discovery and part of the works were evacuated. The BBC news article referenced in the original report incorrectly stated that *“an unexploded World War Two bomb was found”*. The presence of a competent person (eg a UXO banksman) can reduce the possibility that suspected UXO is incorrectly identified and could reduce disruption.

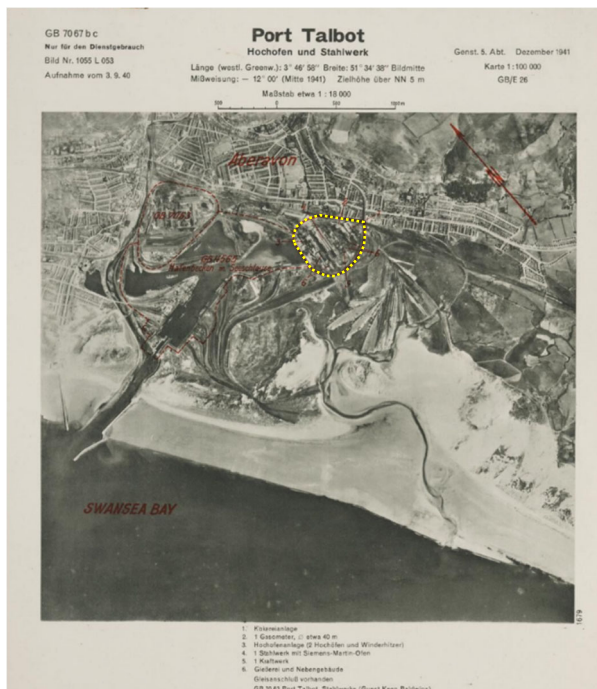
Assessment by Bombs Away of the site's history

In order to complete a suitable UXO risk assessment by considering probability of UXO discovery, it is necessary to establish the how the site has developed over time. RSK included maps and aerial photographs of the site that were produced before and after WW2. We identified additional information which has been incorporated into this report.

Aerial Photography

Sept 1940 vs 2006.

The Luftwaffe photo (below left) was included in the RSK report (p.7) and shows targets in the Port Talbot area; note that north is towards the top left corner of the photo. The closest target to the site has been highlighted with a yellow dotted line. This Luftwaffe photo lists facilities within this zone of interest, including gasometers and the *Siemens Martin Ofen steelworks*. The more recent photo (below right) also shows the target area as a yellow dotted line, with the proposed site boundary as a red dotted line. At its closest, this target is 750 metres north of the site, and 3.5km away from the site's most distant point.



COMMERCIAL-IN-CONFIDENCE

Mapping

Several maps that were not included in the RSK report are reproduced below.

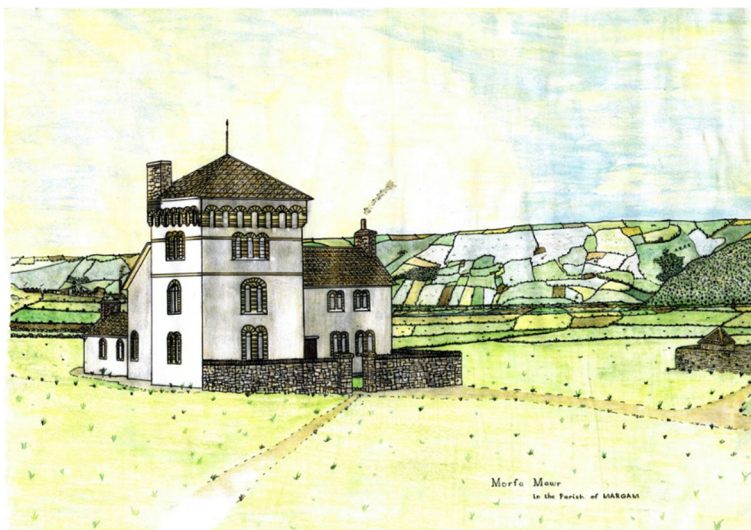
Land usage mapping, revised 1936



Green colouring indicates meadowland or permanent grass; the paler yellow is heath, moorland or rough pasture; the darker yellow is rough marsh pasture; purple indicates housing.

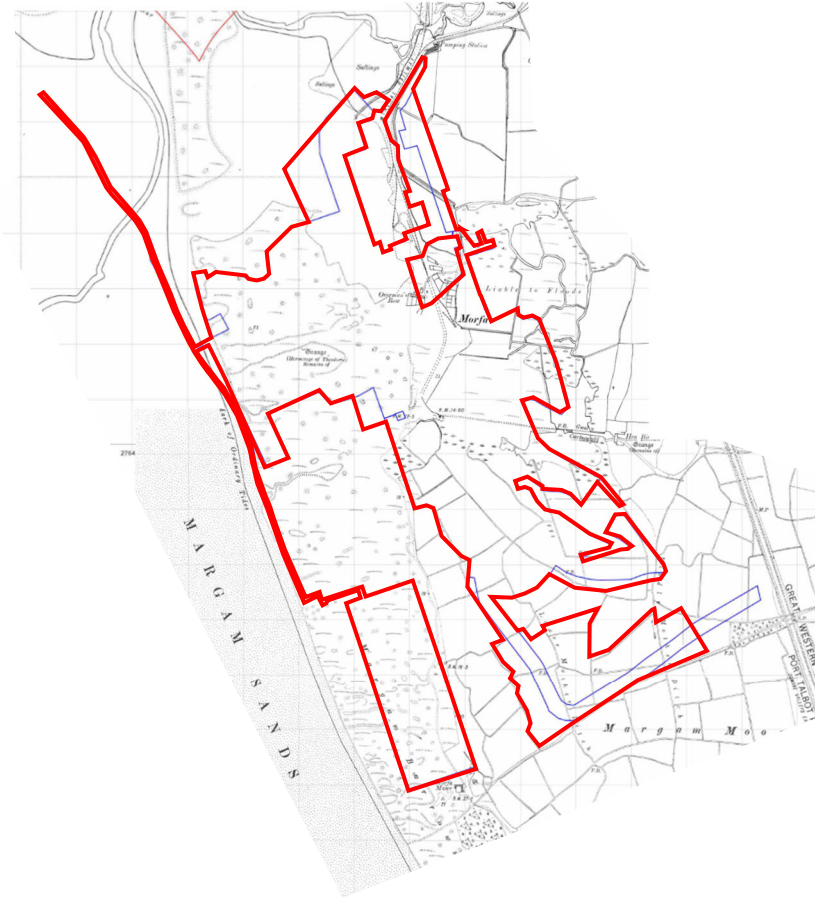
Of note are the two residential areas indicated in purple: former pit buildings to the north and Morfa Mawr to the south.

An undated drawing of Morfa Mawr was located on a local history website and is reproduced below left. The land behind the house appears to be a mix of enclosed fields and rough sand dunes.



COMMERCIAL-IN-CONFIDENCE

Composite of multiple Ordnance Survey maps, 1:10,560, dated 1939.



This map confirms that relatively little of the site had been developed before WW2. The former Morfa Colliery (Grange & Abbot Pits) is shown. Earlier maps had shown additional residential units in the area, known as Office and Pit Row, however only one building now remains in *Overman's Row*.

The remaining land is shown as enclosed grassland, sand dunes or tidal areas.

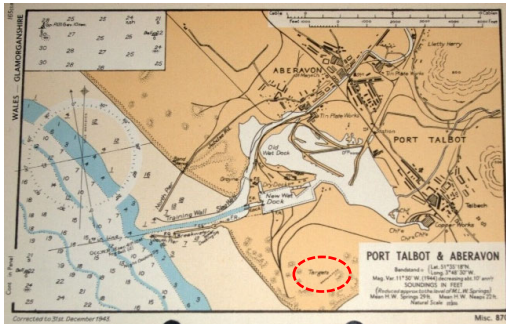
Headland's archaeological report (dated May 2024) included in the planning application includes a map dated 1940 (illustration 30 of their report) in which the residential units and almost all pit infrastructure (including the railway lines) have been removed, as the pits closed in 1913.

The Headland report states *"OS mapping... showed that the only remnants of Morfa Colliery were the old shafts and associated roads and embankments, with a single remaining building noted. The trackway across the site was now a small footpath."* (p.46) Note that this is different to RSK's assertion that *"Morfa sidings were likely associated with Morfa colliery, on site at this point"*.

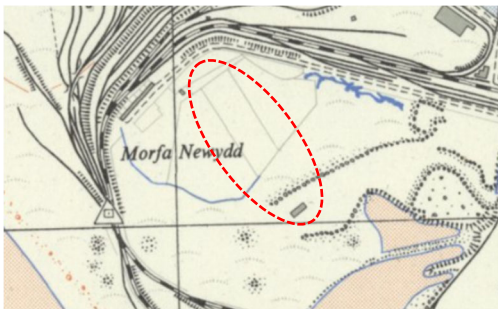
We found reference in the West Glamorgan Archive Service to Morfa Mawr Farm (mentioned earlier), which was located just outside the south-west corner of the site; this said that the farm was only demolished in 1975.

COMMERCIAL-IN-CONFIDENCE

Admiralty map, dated December 1943, 1:22,800

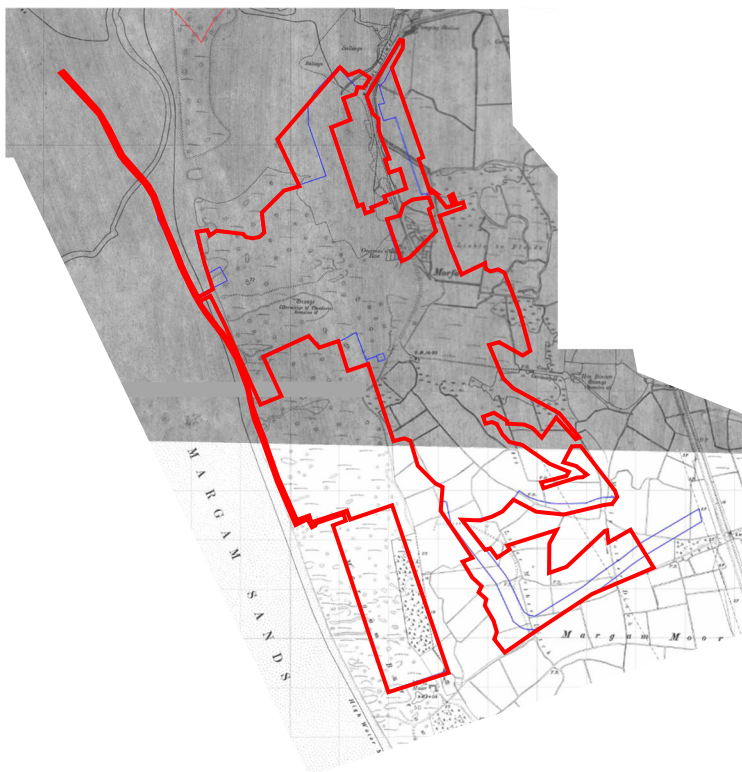


This map includes reference to 'Targets' south of Port Talbot Docks (circled in red for ease of reference), which is almost certainly an additional firing range. No further information could be found confirming the existence of this feature, which is located outside the proposed site boundary.



The post-WW2 Ordnance Survey map (left) published in 1955 shows a rectangular building in a similar location to the targets and the field boundary to the north-west lines up with this building (again circled in red). It is likely that the direction of fire would have been away from the docks (that is from the north-west, towards the south-east) and that firing would have occurred from the aligned field.

Composite of multiple Ordnance Survey maps, 1:10,560, dated 1947.



There has been minimal change to the map since the previous revision was published prior to WW2.

COMMERCIAL-IN-CONFIDENCE



RSK refer to the presence a '*bombing decoy*' on the site (pp. i&7). This potential risk is discussed in more detail later. A map showing the decoy's position based on information available from English Heritage/ CADW data set, is included left. The location of the decoy is identified by a green circle, based on a 6-figure grid reference.

The decoy is very likely to have been permanently staffed when it was operational and air raids were possible.

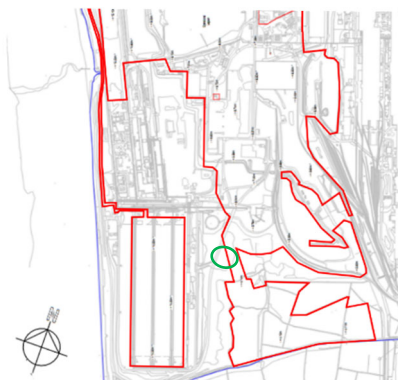
RSK also refer to the firing range formerly located on the site.



A disused '*rifle range*' is shown on the Ordnance Survey 1:2,500 Series A map, published in 1964 (reproduced left) and the same shape is also visible on the May 1949 aerial photo (right).



The 1964 map has been overlaid on a modern aerial photo, then the site perimeter has been added (left). The firing range has been identified in green on the plan (right) to provide a clear indication of its location.



The archaeology report prepared for the planning submission by Headland, includes a 1940 map (illustration 30) which also shows the complex, demonstrating that it existed during WW2.

Aircraft crashes

Bombs Away have searched our written records and database for evidence relating to aircraft crashes in the area, but no information of significance was located.

COMMERCIAL-IN-CONFIDENCE

Additional sources of information

The Commonwealth War Graves Commission database was searched and nothing relevant to the site was found, although the dates that fatalities occurred in Port Talbot corroborated bomb impact data discussed later.

Summary

Based on our research, we conclude that before WW2 the vast majority of the site consisted of enclosed fields, sand dunes and small tidal area. A single building of the Morfa Colliery's physical legacy remained. It is possible that this building and the larger Morfa Mawr building were occupied and used for residential purposes during WW2. The site hardly changed for the duration of WW2, but in addition, a bombing decoy and firing range was constructed during the war in the central area of the site. The bombing decoy is likely to have been permanently staffed for the duration of its operational life.

Shortly after WW2, when the steelworks were constructed, there was considerable redevelopment of the site. This included reclaiming land in addition to the construction works.

Initial review of risks, as identified by RSK

RSK link multiple potential causes of UXO contamination. Six examples now follow:

a. Bombing decoys on site

Within the executive summary (p.i) RSK state that *"two bombing decoys were situated within the south of the site"*. This is repeated in Section 7.2 saying *"a Civil Starfish bombing decoy, intended to replicate the city of Swansea, was situated in the south of the site, alongside a QF decoy to draw bombs away from oil installations at Swansea harbour"* and in Section 7.4 they say, *"evidence suggests the latter may have been targeted twice"*.

RSK also note *"several sources, such as documents sourced from The National Archives and books relating to bombing decoys were analysed, although no evidence relating to the bombing decoys on site was found"* (Section 7.2). In Section 9, RSK say *"no complete set of bombing records exist for the site area; however, a secondary source noting bombing incidents in the region indicates that the site may have been subject to at least two bombing incidents. These occurred on Morfa beach and sidings"* and the two incidents *"likely occurred on site"*.

To develop RSK's statements, a single location on the Tata site has been identified in National Archive documents (1) as a dual-purpose decoy. The location is shown as a green circle on the site plan included earlier. No evidence was found to confirm that the decoy was successful drawing away enemy bombers from their intended targets or that it was hit by air dropped bombs during WW2.

COMMERCIAL-IN-CONFIDENCE

Given that Swansea was subjected to forty successful attacks by the Luftwaffe between June 1940 and February 1943, most notably the three-day blitz in February 1941, this decoy did not achieve its aim.

Decoys were permanently staffed during their operational life, so they could be 'switched on' at very short notice. The soldiers that manned the decoys were expected to observe bomb impacts in the area to assist with the assessment of the decoys' effectiveness. This significantly reduces the probability a bomb would drop unnoticed.

Potential bomb impact locations will be reviewed later in this report.

b. Auxiliary units

RSK make reference to an Auxiliary Unit (p.i), noting their use of *"sub-machine guns and explosives during their training" "on sand dunes in the local area, potentially adjacent to the site"* (p.13) saying that *"these items of UXO also pose a Severe risk of harm"* (p.15).

The Auxiliary Unit RSK refer to was located at Cymmer, *"11.5km north east of the site"* (p.10). There appears to be two sources of information for their assertions: a newspaper article (2) and extracts of a book by Roy Coleman (3), a member of the Cymmer Auxiliary Unit. There is reference to training, but not a precise location, saying the *"Patrol often trained in the dunes on the beach, although... night training came to an end when the number of courting couples in the dunes made it impossible to operate"*. There is reference to training with the Neath Auxiliary Unit, which suggests the dune training took place closer to Aberavon.

Bombs Away located an additional Auxiliary Unit based in Margam (approximately 1km east of the site) and some of the recollections of the Auxiliary Unit members' were recorded on a history website (4), in the media (5) and a book (6). This suggests that a *"local quarry was used for combat and small arms training"*. In the event of an invasion, their targets (and as a consequence potential training areas) are said to have included *"Kenfig Carbide Works, Aberbaiden Colliery, railway sidings, and marshalling yards south of what is now Eglwys Nunnedd Reservoir and main tracks running east west to Port Talbot steelworks and Port Talbot Docks"*.

Bombs Away do not consider the presence of Auxiliary Units to be a likely cause of UXO contamination, given the Auxiliary Unit's base location, known targets and training areas.

c. Firing ranges

The location of the firing range within the site boundary was shown on a map included earlier.

The BBC produced an archive titled the *WW2 People's War* which contains a record from 2005 referring to an RAF firing range in the sand dunes at Margam (7). This describes the author's experience of using a portable *'four gun turret'* and shooting at a model aircraft attached to a trolley that moved around on an electric rail. It is the opinion of Bombs Away that this is almost certainly the firing range shown on the 1964 map, as the location and unusual design concur.

COMMERCIAL-IN-CONFIDENCE

Few traces of the range remain. Photographs of a derelict building said to be the firing point for the rifle range are included in Headland's archaeology report (p. 29). This building is to the east of the site boundary. The embankments visible on the map and aerial photo that surrounded the area used for firing no longer exist. They would have been the 'butts', that is the material used to catch the projectiles fired. The butts are often constructed with heaped sand, which is particularly likely at this location, given the proximity to a beach.

It is possible that the butts were levelled in situ and the projectiles they had caught will remain in the general area of the range. The use of small arms (eg machine guns) at the range means that these items do not pose a UXO hazard. It is plausible that small arms ammunition which was **not** fired could have been inadvertently dropped during WW2, so it is possible that some items remain. The small quantities involved and the time that has elapsed since the range was used makes this eventuality unlikely, however operatives should still be aware of the possibility small arms ammunition could be discovered.

With respect to the second firing range to the north of the site that was identified by Bombs Away and shown on the 1943 map, it is possible that the fired projectiles may have landed on the site. Given the considerable redevelopment that has occurred since WW2, the probability of encountering these items (which do not pose a UXO hazard) is very low.

d. A tank wreck

RSK say that a "*partially submerged tank is also located here, thought to have been used in D-Day exercises*" (p.i) and there is the "*wreck of British Cavalier tank on the beach at Morfa, immediately west of the site [which] may have been involved in exercises related to D-Day and became beached... It is, however, thought to be indicative of military activity in the wider area.*" It is worth noting that relatively few Cavalier tanks were built, as their performance was considered to be unsatisfactory and inferior to the Centaur and Cromwell tanks, so production ceased in 1942 (8). This would reduce the probability that a Cavalier would have been used in training for D-Day.

Other online sources say that it is a tank that was lost when filming the 1943 propaganda film '*Nine Men*' with one reference adding that it was "*bogged down and was left there after the engine was salvaged. For many years the turret was intact but a local child had to be rescued when the hatch jammed. The turret was blown off by the local TA.*" (9)

The wreck is located outside the site boundary and Bombs Away do not consider the risk of UXO to be increased on the site because of its presence.

e. Anti-aircraft (AA) batteries

On page 11 of the RSK report, they state an "*AA shell which did not explode at the correct altitude could have come to contaminate the site.*" They correctly note that there were several heavy anti-aircraft batteries in the general area of the site. Based on information provided in Dobson's authoritative book *AA Command*, Bombs Away have located the three WW2 heavy anti-aircraft gun locations that were closest to (but outside) the site. They were located at Morfa Mawr (reference

COMMERCIAL-IN-CONFIDENCE

N10, south of the site), Margam Park (reference N8, east of the site) and Bryn (reference N9, north-east of the site, for which remains still exist).

We found no evidence that there was also an anti-aircraft battery on Morfa beach, although a coastal defence battery was located north of the site, near the docks.

The majority of rounds fired by the batteries would have been towards the sea. The vast majority of rounds that did not function as planned and returned to the ground were located during WW2. Given the post-WW2 redevelopment of the site, which RSK describe as “*extensive*” (p.13), including reclamation of land and substantial construction works which they acknowledge will have “*mitigated a large degree of risk on site*” and as land service ammunition is “*generally encountered within the top 1m of soil*” (p.8), Bombs Away consider it very unlikely that anti-aircraft rounds could have remained undiscovered within the site area for the 80 years after WW2.

f. Bomb impact locations

RSK have reproduced the WW2 bomb impact statistics (p.8) and acknowledge later in the report that there was a “*very low bomb density*”(p.12). For context, the bombing density for Holborn in London was 235 times heavier, with 921 items dropped/ 1000 acres, compared with Port Talbot, which had 3.9 items dropped/ 1000 acres.

They use secondary sources to list bombing incidents in the local area (p.8), which can be summarised as follows:

1. 29th June 1940, vicinity of Port Talbot/Margam Steelworks, incl 1nr unexploded bomb at Margam’s fitting shop, 9nr bombs outside the Port Talbot General Offices. Target was probably the GKB [Guest, Keen, Baldwin] gas holder.
2. 1st July 1940, railway sidings at Morfa Bank.
3. 30th July 1940, Morfa Beach.

As confirmed earlier during the review of maps, at the time of WW2, there were no longer railway lines to the former colliery, and the steelworks on site had not been constructed; the closest industrial works were 750 metres away from the site perimeter.

Bombs Away also found a secondary source in the form of a local history website (10) which scheduled Luftwaffe attacks on South Wales from 1940-1943. The three events listed by RSK were corroborated with additional detail listing the location that each of the 9nr bombs landed. This included: Tydraw Hill, Oakwood Street, near the Grand Hotel, station approach, railway sidings near the Port Talbot Steelworks, between Margam Coke Ovens & Richard Thomas Steelworks, Talbot House, between the Steelworks & Dock Ferry, and Dinas Powis. None of these locations are within 750 metres of the site perimeter.

COMMERCIAL-IN-CONFIDENCE

The railway sidings at Morfa Bank were about 500 metres outside the site, south of the steelworks identified on the Luftwaffe target photo included earlier within this report.

No additional detail was provided about the bomb impact at Morfa Beach. It is possible that this bomb dropped within the site boundary, however many hectares of Morfa Beach are outside the site perimeter too, so a definitive conclusion cannot be achieved. However, the available records demonstrate that bomb impacts were recorded for all areas of the borough, including some that landed in the sea. This impact would have resulted in a post-raid search of the area.

Swansea Council's website makes the comment about Port Talbot that "*Although bombs fell on industrial sites in 1940, no raid was ever launched there on the scale seen in Swansea*" (11), confirming that the bomb density was considerably lower than other locations in the area.

A website specialising on the history of Port Talbot Docks (12) quoted a newspaper article written by the Port Talbot dock manager in July 1945 saying the "*docks at Port Talbot were exceedingly fortunate in that they experienced very few attacks from the air, and consequently suffered relatively little air-raid damage. The first of the air raids occurred in the early hours of 29th June and 1st July 1940, when a number of bombs were dropped on the docks, some falling close to Messrs. Guest Keen & Baldwins' Margam works, but fortunately there was no significant damage. One lone raider appeared over the docks at 9.52 a.m. on 20th August 1940 and dropped a number of bombs on the south side of the docks, causing damage to dock railway lines, electricity cables and wagons of coal, etc. The necessary repairs were put in hand with immediate effect, however, and everything was fully operational again by the afternoon... Throughout the duration of the war some 512 air-raid alerts were sounded, but no serious damage was ever occasioned to any of the dock property.*"

Residual Risk

Bombs Away assert that WW2 high explosive bombs could pose the most significant risk. This is because: the potential for harm is high due to the large quantity of explosive they contain; they can survive impact with the ground; and they can penetrate several metres of ground. We have included our assessment of the probability that an HE bomb may be encountered during these works later in this report.

General assessment of the RSK report

Additional consideration of the following points is required:

- There would have been frequent access to the site in order to maintain the decoy; there would have been access to the site for users of the firing range; enclosed land/fields within

COMMERCIAL-IN-CONFIDENCE

the site boundary were almost certainly in use for keeping livestock or crops. There may also have been 2nr occupied residential dwellings on or adjacent to the site during WW2.

- Available evidence suggests that one high explosive bomb may have been dropped on or within 500 metres the site.
- There has been substantial redevelopment of the site after WW2.

There is no doubt that the unintended detonation of unexploded ordnance during construction works could cause significant harm, however the absence of an objective method assessing the probability that UXO will be encountered, means that the risk has not been fully assessed.

CIRIA C681 requires that three criteria are used to assess the probability that aerial delivered unexploded ordnance would be discovered during WW2, but the report does not review them, only making passing comments. The criteria to be assessed are:

- Bomb damage in the area, potentially obscuring bomb entry holes.
- Ground cover, which may hide evidence of an unexploded bomb hitting the site.
- Frequency of access, to observe indicators of an unexploded bomb.

We review these criteria in the next section.

COMMERCIAL-IN-CONFIDENCE

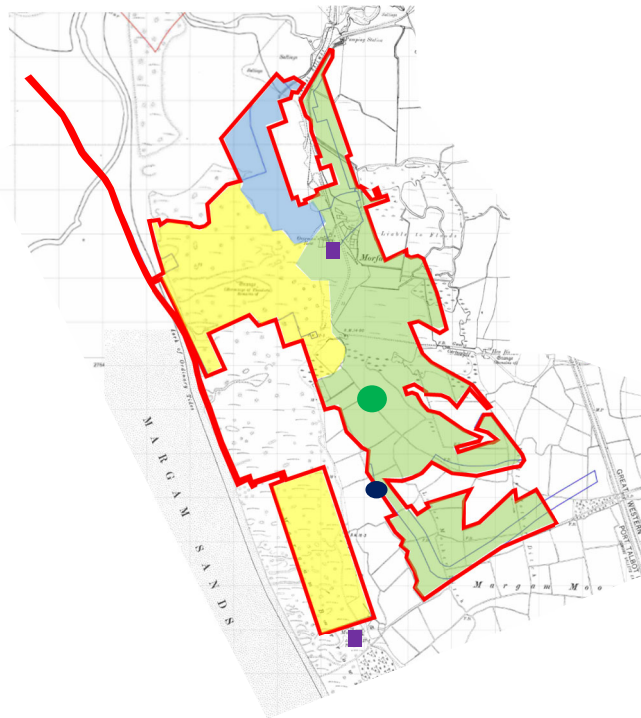
Report review summary

Bombs Away consider there to be two areas of the original report that can be enhanced with additional research:

1. an assessment to estimate the probability that an unexploded bomb would have landed and remained unnoticed,
2. the residual risk of UXO.

This review will now consider these areas, which can then inform appropriate mitigation measures.

Review 1 – bomb damage, ground cover and frequency of access.



In order to assist with this part of the assessment a contemporary map has been coloured to indicate potential access to the various parts of the site.

- Pale green – enclosed fields
- Pale blue – marsh/ tidal area
- Yellow – sand dunes
- Green circle – bombing decoy
- Blue oval – shooting range
- Purple squares – potential residential areas

The criteria to be reviewed are:

- **Bomb damage in the area, potentially obscuring bomb entry holes.**
No bomb damage was recorded in the site area.

COMMERCIAL-IN-CONFIDENCE

- **Ground cover which may hide evidence of an unexploded bomb hitting the site.**

Based on the photos and maps we have examined, about half the site consisted of enclosed fields, about a third of the site was sand dunes; the remainder was marsh/ tidal areas. Entry holes for unexploded 50kg bombs, were typically 200 to 300mm in diameter and for a 250kg bomb entry holes were usually 300 to 450mm in diameter. We consider it very likely that entry holes would have been observed in the enclosed fields, but less likely they would have been observed in the tidal areas or sand dunes. It is worth noting that in addition to the entry holes, there would have been several other indications that there had been an impact without an explosion, such as cracking to adjacent buildings/ ground and ground movement.

- **Frequency of access, to observe indicators of an unexploded bomb.**

We consider it very likely that there would have been access to the whole of the site, excluding tidal areas, during WW2. For the areas coloured green, there would have been frequent access by farmers, and by those using the two military installations (the range and decoy). If the two dwellings at the site of the former colliery and Morfa Mawr were still occupied, it is likely that the occupants would have accessed the whole of the site area. Contrary to a comment by RSK (p.9) we do not agree that "*Morfa Colliery in the centre of the site would likely have seen extensive access*" as it closed before WW1. Port Talbot Docks would have had an air raid precaution (ARP) system in place and given the site's proximity to the docks, it is likely that any bombs that were dropped in the locality would have been seen by the ARP staff and a post-raid search completed.

Review 2 – quantitative assessment to estimate the probability that an unexploded bomb would have landed and remained unnoticed.

This report will provide a meaningful indication of the *probability* that an unexploded bomb (UXB) may be encountered, or a description of what the risk means in practical terms, so that the client can make an informed decision regarding the mitigation required.

As previously stated, *if* WW2 high explosive bombs were to be found on the site, they could now pose a significant risk. This is because the potential for harm is high due to the quantity of explosive in the weapon, the bomb casing is made of 'thick walled' steel, so can survive impact with the ground and they could penetrate several metres underground. However, an assessment of the probability that an HE bomb would be encountered, should be completed. Bombs Away's calculation to assess this probability, follows later in this report.

COMMERCIAL-IN-CONFIDENCE

When UXO has been encountered on UK construction sites, there are very few examples since WW2 where detonation has occurred due to construction processes and the last confirmed fatality was in 1949.

Ordnance that has already exploded, no longer poses the risk. A huge effort was made during and after WW2 to identify, then make safe, bombs that did not explode. This means the bombs that do now pose a risk, were either officially 'abandoned' or never identified. The RSK report correctly acknowledges that there are no known abandoned bombs on the site. If a high explosive bomb were still to be on the site, it would be a consequence of not identifying the weapon during WW2.

RSK assess the maximum bomb penetration depth (p. 9), suggesting that the maximum depth for a 500kg bomb would be 14.25 metres. We agree with this assessment.

Probability that unexploded ordnance would be discovered during WW2

These criteria inevitably permit some subjectivity in the assessment process, given the historical evidence available and the period that has lapsed since WW2. Based on the review of the maps and photographs discussed earlier, it is the opinion of Bombs Away Ltd that:

- One bomb impact recorded at Margam Beach which may have been within the site boundary; we consider the possibility of debris obscuring entry holes to be very low.
- Ground cover was variable across the site and it is plausible that a bomb could have landed in a tidal area or sand dune, leaving minimal evidence of its impact.
- There is likely to have been continued and frequent access to the site for the duration of WW2. Notably the presence of a bombing decoy would mean that the site would have been observed to assess whether bombs were landing in the area and the decoy was effective.

Using these three criteria specified by CIRIA, Bombs Away consider it very unlikely that a high explosive bomb would have landed on the site unnoticed during WW2 and remain undiscovered during post raid searches. We estimate there is a 95% chance a UXB would have been identified at the time, for the reasons explained above and therefore a 5% probability of it remaining undiscovered.

COMMERCIAL-IN-CONFIDENCE

Review 3 – Probability of encountering unexploded ordnance

The RSK report states there is a “*Moderate risk*” from items of German UXO, with no attempt to define or quantify it. An acceptable assessment methodology to quantify the probability of unexploded bombs remaining on the site can be completed as follows. There is an exemplar within CIRIA’s guidance document, C681, which uses a similar process.

Records from The National Archives recording the number of high explosive (HE) bombs dropped on the borough of Port Talbot during WW2 indicate that the bombing density was

= 87 HE bombs/ 23,444 acres

= 87 HE bombs/ 9,488 Ha

= average of **0.00917** bombs/ Ha

Total area of the site = **159.6 Ha**

Theoretical number of bombs dropped on the site during WW2

= 0.00917 bombs/ Ha x 159.6 Ha

= **1.4635** bombs

This means that one or two high explosive bombs would be expected to have landed on the site and it is interesting to note that this broadly corresponds with the evidence found during our research.

It is generally accepted that an average of 10% of high explosive bombs that landed, did not explode, meaning that the theoretical number of unexploded bombs on the site would be

= 1.4635 x 0.1

= **0.14635** bombs

COMMERCIAL-IN-CONFIDENCE

As stated earlier, it is the opinion of Bombs Away Ltd, that there is a 95% chance that any large ($\geq 50\text{kg}$) high explosive unexploded bomb would have been identified (5% chance that they would remain). This is because:

- The vast majority of unexploded bombs were found during or immediately after WW2,
- With very few exceptions (abandoned bombs), those that had been located were removed,
- There may have a single bomb impact on the site
- It is very unlikely there was bomb damage,
- Ground cover was variable and there were tidal areas,
- There is likely to have been continued access to the site for the duration of WW2.

This means that the theoretical number of unexploded bombs remaining on the site is

$$= 0.14635 \times 0.05$$

$$= \mathbf{0.0073177}$$

This indicates that the probability of a WW2 air dropped German bomb (of 50kg or more) remaining on the site, is about 1 in 137.

The probability of an encounter with an unexploded bomb that is on the site is lower than this figure, as this is a large site and relatively little ground is being disturbed during the redevelopment works for the first time since WW2 ended.

Drawings detailing the foundation design of key buildings were provided to Bombs Away Ltd. These drawings have been reviewed and the volume of ground that will be disturbed has been estimated. In order to provide a factor of safety, which also allows for potential design development and temporary works, the quantity of ground to be disturbed has been considerably over-estimated. For example the number of piles has been 'rounded up' by over 200. The area around each proposed pile that could pose a risk to a fuze during the pile's installation has been standardised at a 2m radius. This ignores the proximity to other piles (eg when secant piling), meaning these 'zones of influence' will often overlap. Furthermore, for the purpose of the calculation that follows, we have assumed that no ground has previously been disturbed since the end of WW2.

COMMERCIAL-IN-CONFIDENCE

Total volume of ground under site to the maximum bomb penetration depth

$$\begin{aligned} &= \text{area of site} \times \text{maximum likely bomb penetration depth} \\ &= 159.6 \text{ Ha} \times 14.25\text{m} \\ &= 1,596,000\text{m}^2 \times 14.25\text{m} \\ &= \mathbf{22,743,000\text{m}^3} \end{aligned}$$

Piling

Bombs Away counted 2767nr piles on the drawings provided. We have rounded this figure up to 3000nr piles.

Volume of ground around each pile that may be disturbed due to installation of pile

$$\begin{aligned} &= \pi \times \text{radius}^2 \times \text{maximum likely bomb depth} \\ &= \pi \times 2^2 \times 14.25 \\ &= 180\text{m}^3 \end{aligned}$$

$$\begin{aligned} \text{Allowing for 3000nr piles} &= 180\text{m}^3 \times 3000 \\ \text{Total volume} &= 537,212\text{m}^3 \\ \text{Round up} &= 750,000\text{m}^3 \end{aligned}$$

Ground floor slab (incl basements, ground beams etc)

Volume of ground to be disturbed estimated to be

$$= 419,280\text{m}^3$$

No allowance was made for drainage, construction of roads, installation of cable to the south of the site etc. As such, volume of ground to be disturbed increased to

$$= 1,000,000\text{m}^3$$

COMMERCIAL-IN-CONFIDENCE

$$\begin{aligned}\text{Total volume of ground to be disturbed} &= 1,000,000\text{m}^3 + 750,000\text{m}^3 \\ &= \mathbf{1,750,000\text{m}^3}\end{aligned}$$

$$\begin{aligned}\text{Proportion of ground to be disturbed} &= \text{total volume to be disturbed} / \text{total volume of ground} \\ &= 1,750,000\text{m}^3 / 22,743,000\text{m}^3 \\ &= \mathbf{0.077} \\ &= 7.7\%\end{aligned}$$

The probability of encountering an unexploded bomb during the works

$$\begin{aligned}&= \text{theoretical number of bombs on site} \times \text{proportion of ground to be disturbed} \\ &= 0.0073177 \times 0.077 \\ &= \mathbf{0.000563}\end{aligned}$$

This equates to = 1 in 1,175 sites

Based on this calculation, the probability of encountering a WW2 German high explosive bomb (of 50kg or more), is about one in every 1,175 sites identical to this project.

Research completed by Bombs Away, which has been peer reviewed, was published by the Institution of Civil Engineers. This research indicated that in a 12-year period, the probability of encountering an unexploded bomb on a construction site in London (the most heavily bombed part of the UK) was about 1 in 17,600 – an average of 1 each year.

An encounter with unexploded ordnance does not necessarily mean it will detonate. CIRIA acknowledge that the likelihood of detonating unexploded ordnance is “*far lower*” than encountering it. WW2 German bomb fuzes were electrically initiated, and their power supplies were not designed to last more than six weeks, although the battery life was only confirmed to have expired in the 1970s. It should also be noted that the last confirmed fatality on a UK construction site that was caused by unexploded ordnance, occurred in 1949.

Research published by the Institute of Explosive Engineers (King, C) starts to make an assessment of the effect of ageing on munitions, an area in which there is little research. It notes that “most [ammunition components] will degrade until they can no longer fulfil their role”, but it is “extremely hard to accurately predict the effects and time scales” although it does reduce the potential risk with time.

Section 4. Summary of findings in this review and recommendations

The calculation to determine the probability of encountering a WW2 German HE bomb (of 50kg or more) during these site works, is estimated to be about 1 in 1,175.

As other ordnance that may have contaminated the site during WW2 (such as incendiary bombs and anti-aircraft artillery rounds) have a limited ability to penetrate the ground, in the unlikely event that they did land on the site unnoticed, they would almost certainly have been discovered during the demolition and redevelopment of the site that has occurred since WW2. Bombs Away consider the probability of discovering such a device to be lower than the probability of encountering a WW2 German HE bomb.

Bombs Away Ltd consider this risk to be sufficiently low that implementing site surveys or the use of a UXO banksman are not a proportionate response to the risk for compliance with H&S requirements. The client may still consider the implementation of mitigation measures to be appropriate if the unexpected discovery of UXO (or suspected UXO) may cause an unacceptable delay to the project or disruption to other services for which the client may be held responsible.

An emergency response plan detailing actions to be taken if suspected UXO is discovered should be developed. It is considered appropriate that any person who is working in the ground should undertake a UXO briefing as part of their initial site induction and for toolbox talks on UXO to be regularly completed.

A template for the emergency response plan and a toolbox talk are available for free download on the Bombs Away Ltd website at www.BombsAwayUXO.com

COMMERCIAL-IN-CONFIDENCE

Section 5. References and bibliography

The following documents and information sources have been used to verify information provided in the risk assessment. Bombs Away Ltd have a bespoke geo-referenced database identifying areas of UXO risk, covering the UK, with information taken from these sources.

Airfield Research Group, Munitions 1915 – 1919, Airfield Research Publishing
 Bates, H.E., Flying Bombs over England
 Beckingham, H.W., Living with Danger: The Memoirs of a Bomb Disposal Officer
 Bekker, C., The Luftwaffe War Diaries
 Birtles P., World War 2 Airfields
 Booker, M., Danger UXB
 Carter, E.J., The Diary of an ARP Warden
 Castle, I., London 1914-17, The Zeppelin Menace
 Castle, I., London 1917-18, The Bomber Blitz
 Cashford, N., All Mine! Memoirs of a Naval Bomb and Mine Disposal Officer
 Cashford, N., Ticking Clock: Memoirs of a Naval Bomb and Mine Disposal Officer
 Caulder, A., The Myth of the Blitz
 Chorley, W R., RAF Bomber Command losses of WW2: Vol.1, Aircraft and crew losses 1939-1940
 Chorley, W R., RAF Bomber Command losses of WW2: Vol.2, Aircraft and crew losses, 1941
 Chorley, W R., RAF Bomber Command losses of WW2: Vol.3, Aircraft and crew losses, 1942
 Chorley, W R., RAF Bomber Command losses of WW2: Vol.4, Aircraft and crew losses, 1943
 Chorley, W R., RAF Bomber Command losses of WW2: Vol.5, Aircraft and crew losses, 1944
 Chorley, W R., RAF Bomber Command losses of WW2: Vol 6, Aircraft and crew losses, 1945
 Chorley, W R., RAF Bomber Command losses of WW2: Vol 7, Operational Training Units
 Chorley, W R., RAF Bomber Command losses of WW2: Vol 8, Heavy Conversion Units and Misc Units
 Chorlton, M., Forgotten airfields of WW1
 Christopher J., Balloons at War
 Clarke, N.J., Adolph Hitler's Home Counties Holiday Snaps
 Clarke, N.J., Adolph's British Holiday Snaps
 Clarke N. J., Luftwaffe Target Reconnaissance, German Aerial Photography 1939-1942
 Cocroft, W.D., Dangerous Energy
 Cocroft W. D. & Thomas R. J., Cold War
 Collier B., The Defence of the United Kingdom
 Conen, J., The Little Blitz: the Luftwaffe's last attack on London
 Cooksley, P.G., Flying Bomb
 Cooksley P. G., Royal Flying Corps Handbook 1914-1918
 Dalton, M, The Royal Observer Corps Underground Monitoring Posts
 Deichmann, P., Luftwaffe methods in the selection of offensive weapons, Vol 1
 Deichmann P., The System of Target Selection Applied by the German Air Force in World War II, Vol 1, USAF Historical Studies
 Deichmann P., The System of Target Selection Applied by the German Air Force in World War II, Vol 2, USAF Historical Studies
 Dennis, P., The Territorial Army, 1906-1940
 Dobinson, C., Fields of Deception. Britain's Bombing Decoys of WW II, 2013
 Dobinson, C., AA Command; Britain's anti-aircraft defences of WW II
 Dobinson, C., Twentieth-Century Fortifications in Britain, Vol 2, Anti-Invasion Defences of WWII
 Dobinson, C., Building Radar: Britain's EW chain 1939-45
 Dobinson, C., Operation Diver: Guns, V1 Flying bombs and landscapes of defence, 1944-45
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume I, Anti-aircraft artillery, England's air defence gun sites. 1914 – 46
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume I, Anti-aircraft artillery, Site gazetteer, WWI.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume I. Anti-aircraft artillery, 1914-46, Site gazetteer, WWII HAA & ZAA.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume I, Anti-aircraft artillery, Site gazetteer, WWII LAA.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume I, Anti-aircraft artillery, Sources.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume II, Anti-invasion defences of WWII.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume III, Bombing decoys of WWII, England's passive air defence 1939-45.
 Dobinson, C. S., Twentieth Century Fortifications in England, Volume VIII, Civil defence in WWII, Protecting England's Civil Population.
 Dobinson, C. S., Twentieth Century Fortifications in England, Supporting paper AA/1 Searchlight sites in WWII.
 Ellis, K., Wrecks & Relics, 24th edition
 English Heritage, Survey of Military Sites and Structures: Summary Report
 Falconer, J., RAF Airfields of World War 2
 Falconer, J., RAF Bomber Airfields of World War 2
 Feegan, T., The Baby Killers: German air raids on Britain in the First World War
 Freeman, R.A., Airfields of the Eighth: Then and Now
 Freeman, R.A., UK Airfields of the Ninth: Then and Now
 Fleischer, W., German air-dropped weapons to 1945
 Foot, W., Beaches, Fields, Streets and Hills: The Anti-Invasion Landscapes of England, 1940 (Council for British Archaeology, Research Report No.144, 2006
 Ford, R., Germany's Secret Weapons of WW2
 French, D., Raising Churchill's Army: The British Army and the War Against Germany
 Groves, C., The Home Guard of Britain
 Griehl, M., German Bombers Over England 1940 – 1944
 Halpenny, B.B., Action Stations 4; Military airfields of Greater London
 Hanson, N., First Blitz
 Harrison Place, T., Military Training in the British Army, 1940-1944, Dunkirk to D Day
 Hartley, A.B, Unexploded Bomb: The Story of Bomb Disposal

COMMERCIAL-IN-CONFIDENCE

Hylton, S., Reporting the Blitz – News from the home front communities
 Hogben, A., Bomb Disposal from World War I to the Falklands
 Hoodless, W.A., Air Raid, a diary and stories from the Essex blitz
 Hunt, H.J., Bombs and Booby Traps: Experiences of a Bomb Disposal Officer
 Innes, G. B., British Airfields of the Second World War
 Jappy, M.J., Danger UXB
 Jenkinson, J., RAF UXB: The Untold Story of RAF Bomb Disposal during WW2
 Johnson, D., Hitler's Vengeance on London, V1 and V2
 King, C., The effects of ageing on munitions, IExpE Journal, Sept 2019
 Longmate, N., Hitler's Rockets: The story of the V2
 Lowry, B., 20th Century Defences in Britain
 Lowry, B., British Home Defences, 1940-45
 Lowry, B., Pillboxes and Tank Traps
 McCamley, N. J., Secret Underground Cities
 McCamley, N. J., Secret History of Chemical Warfare
 McCamley, N. J., Cold War Secret Nuclear Bunkers, the Passive Defence of the Western World During the Cold War
 Marguard, E.A., Luftwaffe methods in the selection of offensive weapons, Vol 2
 Moran, P.J., Wreck Recovery in Britain, Then and Now
 Morris, J., German Air Raids on Britain 1914-18
 Myatt, F., The British Infantry, 1660-1945
 Ogley, R., Doodlebugs and Rockets, the Battle of the Flying Bombs
 Osborne, M., Defending Britain: Twentieth-Century Military Structures in the Landscape
 Osborne, M., Defending Britain: Twentieth-Century Defences in the London Area
 Osborne, M., Pillboxes of Britain and Ireland
 Owen, J., Danger UXB, The Heroic Story of WWII Bomb Disposal Teams
Owen, M. et al, The risk of unexploded ordnance on construction sites in London, UK. Environmental Geotechnics, Institute of Civil Engineers Publishing.
 Parker, N., Luftwaffe Crash Archive: Volume 1. September 1939 – 14 August 1940,
 Parker, N., Luftwaffe Crash Archive: Volume 2. 15 August 1940 – 29 August 1940
 Parker, N., Luftwaffe Crash Archive: Volume 3. 30 August 1940 – 9 September 1940
 Parker, N., Luftwaffe Crash Archive: Volume 4. 10 September 1940 – 27 September 1940
 Parker, N., Luftwaffe Crash Archive: Volume 5. 28 September 1940 – 27 October 1940
 Parker, N., Luftwaffe Crash Archive: Volume 6. 28 October 1940 – 31st December 1940
 Parker, N., Luftwaffe Crash Archive: Volume 7. 1st January 1941 – 16th April 1941
 Parker, N., Luftwaffe Crash Archive: Volume 8. 17th April 1941 – 24th July 1941
 Parry, S. W., Intruders over Britain – The Luftwaffe Night Fighter Offensive 1940 to 1945
 Pawlas, K.R., Deutsche Bomben
 Price, A., Blitz on Britain: 1939-1945
 Quarrie, B., Action Stations 10; Supplement and index
 Ransted, C., Bomb Disposal in World War Two
 Rothnie, N., Baedeker Blitz: Hitler's Attack on Britain's Historic Cities
 Philpott, P., German Bombers Over England
 Ramsey, W., The Blitz Then and Now Volume 1
 Ramsey, W., The Blitz Then and Now Volume 2
 Ramsey, W., The Blitz Then and Now Volume 3
 Ransted, C., Disarming Hitler's V weapons. Bomb disposal: The V1 & V2 Rockets
 Ransted, C., Bomb Disposal and the British Casualties of WW2
 Ray, J., The Night Blitz 1940 – 1941
 Redfern, N.I., Twentieth Century Fortifications in the United Kingdom
 Reynolds, D., Rich Relations, the American Occupation of Britain 1942-1945
 Ruddy, A.J., British anti-invasion defences 1940-1945
 Smith, D. J., Britain's Military Airfields 1939-45
 Smith, P.J.C., Air-launched Doodlebugs – The Forgotten Campaign
 Stansky, P., The First Day of the Blitz
Stone et al, Unexploded Ordnance (UXO) – A guide for the Construction Industry. CIRIA C681
 Sansom, W., The Blitz
 Tucker, J. B., War of Nerves
 Turner, J.F., Highly Explosive
 Varey, P., Life of the Edge
 Veronico, N A., Hidden Warbirds II
 Wakefield, K., Pfadfinder – Luftwaffe Pathfinder Operations Over Britain, 1940-44
 Wakefield K., Operation Bolero
 Wakeling, E.E., The Danger of UXBs
 Wakeling, E.E., The Lonely War
 Wakeling, E.E., A Photographic Story of War Time Bomb Disposal
 Wakeling, E.E., A Short History of Royal Engineer Bomb Disposal
 Westlake, R., The British Army of August 1914, 2005
 Whiting, C., Britain Under Fire: The Bombing of Britain's Cities, 1940-1945
 Williamson, G., Luftwaffe Handbook 1935-1945, 2006
 Wills, H., Pillboxes: a study of UK defences 1940
coflein.gov.uk/en/site/409374/
 Robins, N., Eye of the Eagle, Luftwaffe Intelligence and the South Wales Ports 1939-41
historicalporttalbot.com/barrie-flint-art.html

COMMERCIAL-IN-CONFIDENCE

1. National Archive references: AIR 20/4352 & AIR 14254
2. <https://www.theguardian.com/lifeandstyle/2007/oct/20/weekend.owensheers>
3. Coleman, R., From Cregan to Corrwg - A Valley Boy's Story, 2005
4. <https://www.staybehinds.com/patrol/margam-patrol>
5. <https://www.staybehinds.com/files/article-library/Dillwyn%20Thomas%20-%20Margam%20Patrol%20Glamorgan%20-%20Daily%20Mirror%20-%203%20Jan%202013.pdf>
6. Thomas, D., A View From The Main Ring
7. <https://www.bbc.co.uk/history/ww2peopleswar/stories/53/a7793553.shtml>
8. Fletcher, D., The Great Tank Scandal: British Armour in the Second World War, 1989
9. https://www.reddit.com/r/CompanyOfHeroes/comments/hd9u4g/remains_of_a_centaur_tank_in_port_talbot_rip_axis/?rdt=52684
10. http://www.islandfarm.wales/Luftwaffe_Attacks_On_South_Wales.htm
11. <https://www.swansea.gov.uk/ArchivesBlitzNPT?lang=en>
12. <http://www.swanseadocks.co.uk/docksnewsite/ptwar.html>