Immingham Green Energy Terminal

9.3 Applicant's Responses to the Examining Authority's First Written Questions

(Responses to "Q1.13. Construction Effects")

Infrastructure Planning (Examination Procedure) Rules 2010

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1 Introduction

Overview

1.1 This document has been prepared to accompany an application made to the Secretary of State for Transport (the "Application") under section 37 of the Planning Act 2008 ("PA 2008") for a development consent order ("DCO") to authorise the construction and operation of the proposed Immingham Green Energy Terminal ("the Project").

1.2 The Application is submitted by Associated British Ports ("the Applicant"). The Applicant was established in 1981 following the privatisation of the British Transport Docks Board. **The Funding Statement [APP-010]** provides further information.

1.3 The Project as proposed by the Applicant falls within the definition of a Nationally Significant Infrastructure Project ("NSIP") as set out in Sections 14(1)(j), 24(2) and 24(3)(c) of the PA 2008.

The Project

1.4 The Applicant is seeking to construct, operate and maintain the Immingham Green Energy Terminal, comprising a new multi-user liquid bulk green energy terminal located on the eastern side of the Port of Immingham (the "Port").

1.5 The Project includes the construction and operation of a green hydrogen production facility, which would be delivered and operated by Air Products (BR) Limited ("Air Products"). Air Products will be the first customer of the new terminal, whereby green ammonia will be imported via the jetty and converted on-site into green hydrogen, making a positive contribution to the UK's net zero agenda by helping to decarbonise the United Kingdom's (UK) industrial activities and in particular the heavy transport sector.

1.6 A detailed description of the Project is included in **Chapter 2: The Project** of the Environmental Statement ("ES") **[APP-044]**.

Purpose and Structure of this Document

1.7 This document contains the Applicant's responses to those of the Examining Authority's Written Questions 1 **[PD-008]** grouped under the theme "Q1.13. Construction Effects". It represents one of a collection of eighteen such documents, each of which addresses a different theme.

1.8 Responses are ordered ascendingly by reference number, replicating the structure of the Examining Authority's Written Questions 1.

1.9 Responses are provided in a table. The text of the question appears on the lefthand side, with the Applicant's answer to its right.

1.10 Further materials pertinent to the Applicant's response are included at the end of the document as appendices where necessary.

2 Applicant's Responses to the Examining Authority's First Round of Written Questions

Q1.13. Construction Effects	
Q1.13.1 General Construction Issues	
Q1.13.1.1	
Question	**Response**
Concrete Batching Plant Reference is made within ES Chapter 2 [APP-044, Paragraph 2.5.2] to the use of a concrete batching plant. Clarify where such a plant would be located, how long it would be positioned on site for and whether it has been assessed within the ES.	**Table 2-11** in **Environmental Statement ("ES") Chapter 2: The Project [APP-044]**, indicates in the right-hand column that the concrete batching plant is likely to be located on the East Site (Work No. 5) as follows: "*East Site – Hydrogen Production Facility for contractor offices, car parking, laydown storage in addition to a possible concrete batching plant and pile welding facility*". The batching plant is expected to be used during Phase 1 of the Project when the bulk of the concrete works are carried out. It is important to note that each of the technical assessments presented in the **ES** consider all elements of the Project defined in the Project description, including the concrete batching plant, provided in **ES Chapter 2 [APP-044].** Whilst the batching plant and associated material stockpiles are not explicitly listed, **ES Chapter 13: Landscape & Visual Impacts [APP-055]**, which is the most relevant assessment in relation to a batching plant, considers the impacts associated with construction at **Paragraph 13.8.3**, as follows: "*With regard to the Project construction phase (and decommissioning),*

	potential landscape/seascape and visual amenity impacts relate to the following: *...e. The introduction of stationary and moving plant including cranes and piling rigs, jack-up barge and other high-level construction machinery and marine construction vessels.* *f. The introduction of low-level construction operations including temporary stockpiling or storage of materials, contractor/welfare facilities and temporary laydown areas.*"
Q1.13.1.2	
Question	**Response**
Early Works Strategy ES Chapter 2 [APP-044, Paragraph 2.5.4] refers to the preparation of an early works strategy. Has this been submitted to the ExA, if not provide a copy. Given the AD and 'ancillary works' referred to in paragraph 2.5.25 of ES Chapter 2, the ExA consider it important to have this strategy submitted and fully considered.	The response below sets out the early works strategy. **Table 2-10** of **Environmental Statement ("ES") Chapter 2: The Project [APP-044]** presents the indicative construction phasing timeline for the Project, including the associated development and ancillary works. Based on that programme, it is anticipated that the green ammonia from the Middle East will be available in Europe for processing before the Project is operational. Therefore, there is an opportunity to consider whether 'early works' can be undertaken to de-risk the potential of any slippage in delivery or potentially bring forward the date on which the Project could be operational and so be able to deliver the benefits arising from the production of hydrogen earlier than might otherwise be the case. The construction of early works for the hydrogen production facility could allow the programme to be brought forward by up to six months and would also enable some terrestrial works to be undertaken ahead of, for example, the discharge of requirements.

	The early works are applicable to the landside works only, relating to the West Site (Work No. 7) and East Site (Work Nos. 3 and 5). The early works do not relate to the Nationally Significant Infrastructure Project (Work No. 1), the jetty access road (Work No. 2), pipelines or culverts (Work Nos. 4 and 6), or temporary construction areas (Work No. 8 and Work No. 9). In the usual way, ABP and Air Products will undertake prudent estate management including works not falling under the definition of 'development' as set out in the Town and Country Planning Act 1990 ("TCPA 1990"). These works include tree and vegetation clearance, where this does not require a felling licence and in relation to trees which are not subject to other protections, and the clearance of ditches. ABP and Air Products are discussing with North East Lincolnshire Council ("NELC") as local planning authority a number of potential planning applications to be submitted under the TCPA 1990 relating to early works. There have been two meetings with NELC, on 12 December 2023 and 6 March 2024. The first planning application would seek approval for test piles on Work No. 3 (Ammonia Storage Tank, East Site) and Work No. 7 (West Site). Test piling is required in order to finalise the piling design for the hydrogen production facility. The area for test piling is limited, comprising less than one hectare. The content of the first planning application was discussed with NELC at the meeting held on 6 March 2024 and the application is scheduled to be submitted in March 2024. A second planning application is anticipated to relate to various early works on the East Site (Work Nos. 3 and 5) and the West Site (Work No. 7). Most of these works would be required to prepare these sites for any subsequent development (noting that the West Site is allocated for B1, B2 and B8 uses

	in the North East Lincolnshire Local Plan, benefits from an extant planning permission and the majority of the East Site lies within the operational port boundary and subsequently benefits from permitted development rights). It is anticipated that the works could include the installation of a new open drainage network, clearing of drainage ditches, installation of fencing, land levelling, backfilling and soil remediation works, installation of a temporary power network, installation of a drainage system/network including retention pond(s), the creation of temporary entrance off the A1173 and vegetation and tree removal. In addition, permission may also be sought for piling works on the East Site and West Site, potentially as a standalone planning application. Seeking planning approval through the TCPA 1990 for any early works is not anticipated to lead to a requirement for any material alterations to the Development Consent Order ("DCO") application. The early works already form part of the Project and have been assessed in the **Environmental Statement** as stated at **Paragraph 2.5.4** of **ES Chapter 2: The Project [APP-044]**. It is therefore not anticipated that there will be any materially new or materially different environmental effects of the works undertaken pursuant to the DCO, taking account of other projects, as a result of the early works (in summary, those environmental effects that do occur will be brought forward in time). However, it is proposed to submit a brief report of the environmental effects of the early works and the Project (together with all other cumulative developments), demonstrating that the effects are not materially different. It is anticipated that this report will be submitted at Deadline 3.
Q1.13.1.3	
Question	**Response**

Assessment Approach ES [APP-044, Paragraph 2.5.1] identifies that the construction approach outlined is considered to be representative of a reasonable worst-case scenario of how the Proposed Development would be implemented. Provide further explanation of how, along with examples	**Paragraph 2.5.1** of **Environmental Statement ("ES") Chapter 2: The Project [APP-044]** states: "*The approach to Project construction described in the following sections is indicative. However, it is considered to be representative of a reasonable worst-case scenario of how the Project would be implemented and the description provided here has been used as the basis of the EIA for the construction phase*". A reasonable worst-case approach for construction assessment uses precautionary estimates of plant type, plant number, working methods and vehicle numbers such that an appropriate envelope of effects is defined, with some built in contingency. This is in accordance with the approach used within Environmental Impact Assessment ("EIA") known as the Rochdale Envelope, and explained at **Paragraph 2.4.2** of **ES Chapter 2 [APP-044]** which states: "*In order to ensure a robust assessment of the likely significant environmental effects of the Project, the Environmental Impact Assessment ("EIA") was undertaken adopting the principles of the 'Rochdale Envelope' approach where appropriate. This involves assessing the maximum (or where relevant, minimum) spatial and vertical parameters for each Work No.. Where this approach is being applied to the specific aspects of the EIA, this is confirmed within the relevant chapters of this Environmental Statement ("ES"). As such, the ES presents a reasonable worst-case assessment of the potential impacts of the Project.* ***Chapter 5: EIA Approach [TR030008/APP/6.2]*** **[APP-047]** *explains further the concept of the 'Rochdale Envelope', the use of parameters and the meaning of a 'reasonable worst case' to undertake EIA.*" The following examples illustrate this approach, specifically in relation to construction. **Construction Workforce** **Paragraph 2.5.28** of **ES Chapter 2 [APP-044]** states: "*During construction,*

	it is predicted that the workforce supporting the marine works would peak at approximately 220 personnel and the landside workforce would peak at 792. Both workforce peaks would be during Phase 1 of construction and for a 'realistic worst case assessment', it is assumed that the marine and landside terrestrial peaks would occur at the same time and during Year 2 of construction. A total construction workforce figure of 1012 workers has therefore been used to inform the assessments in ***Chapter 11: Traffic and Transport [TR030008/APP/6.2]*** *and* ***Chapter 23: Socio-Economics [TR030008/APP/6.2]****.*" (underline added for emphasis) It is unlikely that the precise workforce peaks will occur at precisely the same time, but there is a small chance they could do so, and hence the approach is regarded as a reasonable worst case. **Construction Materials** **Paragraph 2.5.43** of **ES Chapter 2 [APP-044]** states: "*Estimates of the types and quantities of materials required to construct the Project, and those generated by construction, have been developed in order to inform the ES. The estimates are precautionary and allow the environmental assessments to consider a reasonable worst-case scenario.*" In this case, a margin has been added to the materials estimates, to create larger values and so ensure a reasonable worst case. **Construction Traffic** **Paragraph 11.4.1** of **ES Chapter 11: Traffic & Transport [APP-053]** states: "*The assessment scenario considered in this chapter relates solely to the construction phase which commences in early 2025 with a peak of construction in Month 23 in late 2026. This therefore represents a worst case as the number of construction workers will vary and reduce over the*

	period of construction." In this case, the worst-case month of the construction traffic profile has been taken as representing the whole of the construction phase, when the peak is only for a relatively short period. This ensures that the construction assessment for traffic represents a realistic worst case. In that regard, Table 3 & 4 in the Outline Construction Traffic Management Plan **[APP-223]** provides the total number of HGVs which has been compressed into a twelve-month programme rather than using the full programme of between two and half to three years for Phase 1. This therefore provides a robust assessment as in reality average flows will be considerably lower and will account for any daily variations in construction activity.
Q1.13.1.4	
Question	**Response**
Street Works – Work No. 10 a) With respect to Work No. 10, confirm what discussions have taken place with the LHA in relation to the proposed street works. b) LHA, are you satisfied with the Applicant's approach towards these works? If not, explain what additional detail is required.	Street works in Work No. 10 relate to the movement of abnormal loads/out of gauge equipment or modules from the Port of Immingham to the site. As described in **Environmental Statement Chapter 2: The Project [APP-044] Paragraphs 2.5.20 - 2.5.22**, these street works would involve the temporary removal or adjustment of some traffic separation bollards at a mini roundabout, some overhead BT Openreach cables on Kings Road and some lampposts at the A1173/Kings Road roundabout. A presentation was given to the local highway authority on 21 April 2023 outlining these requirements and it was agreed that a formal application would be submitted by the specialist heavy haulage company appointed by Air Products 3–6 months before the required movements, in accordance with the typical process.

Q1.13.1.5	
Question	**Response**
Removal of Street Furniture Street furniture removal is required, as is the raising of overhead cables, no detail is provided on how this would be done or whether the approach has been discussed and agreed with the relevant highway authority and statutory undertakers. The overhead cables are not described in detail regarding their current use and who may be affected by this, further details are required from the Applicant to clarify and justify the works. Further detail is required from the Applicant to determine how the street furniture would be removed, where it would be stored, whether their removal would impact upon the safety of road users, and when and how it would be reinstalled.	Applications for street furniture removal in the UK, using out of gauge transportation, are a well-known process for local highway authorities. Air Products advised North East Lincolnshire Council ("NELC"), the local highway authority, in a meeting held 21 April 2023, that removal of some street furniture would be required. NELC acknowledged that this was a standard process. The street furniture items which may require removal for some specific abnormal loads are identified below:

		
Temporary removal of traffic separation bollards on Kings Road	Temporary removal of lamp posts at Kings Road / A1173 roundabout	Temporary removal of overhead Openreach cables from pole on Kings Road

	The removal is required because some specific abnormal loads travelling from the port may be too long, wide or high to pass without interfering with the above items. The normal process, as per the Road Vehicles (Authorisation of Special Types) (General) Order 2003 ("STGO") and the Road Vehicles (Construction & Use) Regulations 1986 ("C&U") is to submit formal applications to the local highway authority in advance of each abnormal load including a transport configuration drawing showing the final equipment details and trailer configuration. This can only be completed when the shipping and lifting drawings for each item are ready. These shipping and lifting drawings will not be available until a few months after design is complete and once available, Air Products' heavy haulage specialist contractor will complete transport drawings which will give the exact size and weight of load plus vehicle. At that point, the final assessment of exactly what street furniture must be removed for the particular load, will be made using swept path analysis drawings, which will be part of the application. Removal of street furniture such as traffic separation bollards or lampposts will be carried out by a subcontractor agreed with the local highway authority. Overhead cables connect four houses to Openreach utilities (within Work No. 10 on Kings Road). The Air Products' specialist heavy haulage contractor will assess in detail any affected cables and engage with all stakeholders at the time of application. As per **Paragraph 4.1.2** of the **Outline Construction Traffic Management**

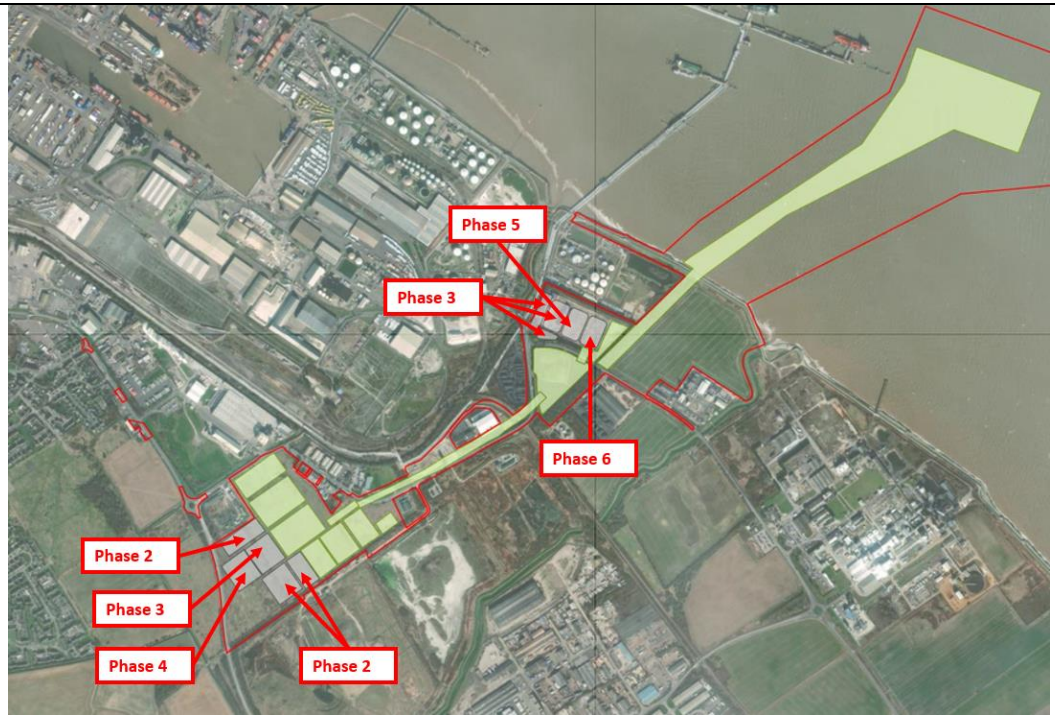
	Plan [APP-223] the contractor will liaise fully with the Police, Local Highway Authority and if required National Highways regarding any abnormal indivisible load ("AIL") movement to ensure that all required measures and approvals are in place. Abnormal loads will only be moved at night (approximately 23:00–06:00) and so any impact to residents and local businesses will be minimal. Adjustment of overhead cables will be carried out by the relevant stakeholder (Openreach) and reinstatement will be undertaken the same night once the abnormal load movement has passed. Some abnormal loads will require police escorts, who will drive the route stopping any public traffic and ensuring safety of the public, infrastructure and load. Any street furniture removal will take place each night to facilitate the movement of the abnormal load and will be reinstalled the same night. Air Products will use a subcontractor agreed with the local highway authority for this work. Temporary storage will be arranged adjacent to the road. The same subcontractor and equipment will be used for removal and re-instatement of street furniture.
Q1.13.1.6	
Question	**Response**
Import of Material The ExA note the Applicant's intention to utilise the Port of Immingham for the delivery of the largest abnormal loads. Has the potential for the use of the Port to import other materials	The jetty construction will include the use of large diameter steel piles, fabricated steelwork and pre-cast concrete elements. It is likely that, once appointed, the main works contractor would look to utilise the Port of Immingham or Grimsby for offload, storage and onward shipping to the jetty work location. The use of the Applicant's existing and extensive port infrastructure for the import of these construction elements will simply form

been considered? If discounted, explain and justify why.	part of existing cargo handling activity which takes place on a day-to-day basis. Existing lo-lo (Lift-on – lift-off) facilities at Grimsby and Immingham exist in numerous different locations and are specifically designed to have the optional flexibility to handle wide ranges of cargos 'under the hook'. Other low volume construction materials such as ready-mix concrete, aggregates, drainage materials and asphalt are likely to be better supplied via the local road network and are included in the material quantities included in the Outline Construction Traffic Management Plan **[APP-223] Tables 3 and 4.** All landside deliveries for the jetty would be required to comply with the **Outline Construction Traffic Management Plan ("CTMP") [APP-223]**. The construction execution strategy for the hydrogen production facility is, as far as possible, to pre-fabricate components of the facility into large modules and preassembled piperacks. These modules will be shipped through the port and will likely be abnormal loads when transported from the port to the site. In addition to the large modules and large equipment items which may be abnormal loads, there will also be other smaller modules and equipment items shipped through the port wherever practicable. Either way, it is expected that the majority of equipment items would be imported this way and this is the basis of the HGV movements assessment given in **Table 3** of the **Outline Construction Traffic Management Plan [APP-223]**. For bulk items such as cable, cable tray, piping, pipe supports, concrete, rebar and civil materials, which may be supplied from the UK or Europe, the most effective delivery method is likely to be by road. **Table 3** of the **Outline Construction Traffic Management Plan [APP-223]** estimates the number of HGV movements for delivery of these items.

Q1.13.1.7	
Question	**Response**
Depth of Pipes The Applicant is requested to confirm whether the stated depth of the pipes in Work No. 6 has been assessed as a worst case scenario at 10m?	The pipelines will be installed using a trenchless methodology (Horizontal Directional Drilling) as outlined in Environmental Statement ("ES" Chapter 2: The Project [APP-044], Paragraph 2.4.48). The ES stated that this will include multiple pipeline sleeves 'which will be installed at expected depths from 5m to 10m at their anticipated deepest point, rising to the surface at each end in Work Nos 3 and 7. However, it is considered that the installation of the pipelines at any depth deeper than 2m below current ground levels (to avoid buried utilities) and shallower than 18m below current ground levels (to keep above the chalk formation) would not have any material impact on the assessment in relation to the main pipeline corridor defined by Work No 6 but excluding (in relation to minimum depth) those parts which overlap with Work Nos 3 and 7, where each end of the pipeline would reach the surface. Within those parts of Work No 6 as described, any depth below 2m and shallower than 18m would not generate significant adverse effects and any depth between these two parameters can be regarded as a worst case.
Q1.13.1.8	
Question	**Response**

Utility Connections Work No.2 Additional details regarding the utility/ service connections to Work No. 2 are requested from the Applicant in a similar format to those described for Work Nos. 1, 3, 5, and 7 in ES Tables 2-4, 2-7, and 2-9 in ES Chapter 2 [APP-044].	Utility/service connections for the Terminal are detailed in the **Utilities Statement [**APP-239**]**. **Table 2-4** in **Environmental Statement ("ES" Chapter 2: The Project [APP-044]** provides the details of the utility connections needed for the Terminal. These connections sit within the area in which Work No. 2 overlaps with Work No. 5, as shown on sheet 4 of 7 of the **Works Plans [AS-002]**. The utilities would then pass through Work No. 2 [to Work No 1 (the jetty)] via the pipe rack infrastructure, adjacent to the jetty access road.
Q1.13.1.9	
Question	**Response**
Construction and Operational Phases The ES [APP-044, Paragraph 2.4.79] refers to ES Table 2-9, however this seems to be incorrect and should refer to ES Table 2-10. The Applicant is requested to clarify this.	**Paragraph 2.4.79** of the **Environmental Statement Chapter 2: The Project [APP-044]** refers to **Table 2-9** in error. The reference should be to **Table 2-10**. This correction is included in the **Table of Errata** submitted at Procedural Deadline A **[PDA-010]** (see Errata List No. 13).
Q1.13.2 Construction Period	
Q1.13.2.1	
Question	**Response**

Construction Period ES [APP-044, Paragraph 2.4.79], sets out the staged approach towards construction, with Table 2-10 providing a timeline for the construction of the Proposed Development. Notwithstanding the submitted information, provide further detail to explain and justify the construction phasing timeline, in particular the 8-year construction period that is envisaged for Phases 2 to 6. The ExA considers it would be helpful to have the drawing showing the various phases of development and how they relate to the detail provided in Table 2-11 [APP-044].	Construction of the Project is anticipated to take up to 11 years. The construction of the Terminal and the first phase of the hydrogen production facility comprises the first phase of development. As stated in **Paragraph 2.4.78** of **Environmental Statement ("ES") Chapter 2: The Project [APP-044]**, the first phase of construction is likely to last for between two and a half and three years. As stated in **Paragraph 2.4.79** of **ES Chapter 2: The Project [APP-044]**, the remaining phases of the hydrogen production facility would be constructed incrementally as the market for green hydrogen increases, taking up to a further eight years. The timescales for Phases 2 to 6 of the construction period reflect the realistic build out time of the remaining parts of the hydrogen production facility. The construction timescale aligns with the expected growth of the hydrogen market, such that the construction of later phases of the hydrogen production facility is intended to correspond with an increased demand for hydrogen as the UK's hydrogen economy develops. The build out of subsequent phases is also related to 'constructability', meaning that it would not be feasible to build all phases of the hydrogen production facility at the same time, this being a function of specialist labour and equipment availability and site congestion. There may be some overlap between phases to account for market development (and whether demand is greater for liquid hydrogen for HGV or industrial hydrogen at that time), for example as shown for Phases 4 and 5. The effects associated with the 8 year build out of Phases 2-6 would always be substantially less that those associated with Phase 1, which is the peak of construction, and so the worst case for the construction period as a whole. A plan has been provided below which illustrates Phase 1 (in green) and Phases 2–6 (in grey and numbered) of construction to aid understanding of the various phases of development. This should be read alongside **Table 2-11** of **ES Chapter 2** which contains the details of each construction phase.

	
Q1.13.3 Construction Compounds	
Q1.13.3.1	
Question	**Response**

Laporte Road Temporary Construction Area In relation to Laporte Road Temporary Construction Area (Work No. 9), reference is made in ES [APP-044] to an initial area for access and laydown being required, with further areas being required progressively as the construction of the Proposed Development progresses. Notwithstanding the details provided in ES [APP-044, Plate 2-4], provide further details of how this area would be brought forward during the construction stage, including details of timings, locations, uses and to support what stages of the Proposed Development. The ExA consider that showing this detail on a drawing would be helpful.	An updated indicative drawing for Work No. 9 is provided in the response to Q.1.4.2.4. Air Products would utilise the areas shown on this indicative drawing for the tank contractor parking area and the pipeline laydown area. The contractor parking and laydown areas would support the construction of Work No. 3 (the ammonia tank on the East Site) and Work Nos. 4 and 6 (the Laporte Road culvert and the Pipeline Corridor respectively). It is anticipated that the full extent of this area would be used from the beginning of construction for parking and laydown and only for Phase 1 of construction of the Project (three years). It should be noted that the use of the contractor parking area will fluctuate in line with anticipated construction activity. For example, **ES Chapter 11: Traffic & Transport [APP-053]** notes that there would be a peak of construction activity, and therefore more construction workers, in month 23 in late 2026 (Year 2). The Applicant would utilise part of the same area on the indicative drawing, again during Phase 1 of the Project only. The jetty laydown area would support the construction of Work No. 1 (i.e. the Immingham Green Energy Terminal). Once established the jetty contractor could utilise the area for locating construction support infrastructure such as offices, worker welfare, parking, or logistics holding.
Q1.13.3.2	
Question	**Response**

Laporte Road Temporary Construction Area Reference is made in ES [APP-044, Paragraph 2.5.19] to the reinstatement of Laporte Road Temporary Construction Area to its 'original state' upon completion of the work. Explain what surveys will be undertaken prior to the commencement of its use to establish its 'original state' and how and who would be responsible for approving this. How long after the completion of work is this anticipated to be?	The land required for Work No. 9 is in the ownership of two separate landowners who each own a section of the field (currently used for agricultural purposes). The powers contained in Article 31 apply to the land, which can therefore be temporarily possessed for the purposes of the construction of the Project pursuant to that Article. If possession is taken under Article 31, under Article 31(5), before giving up possession the undertaker must restore the land to the reasonable satisfaction of the owners (subject to the terms of that Article). Compensation is payable for loss or damage arising. Option agreements for the grant of a lease of the relevant land are being negotiated with both landowners. The drafts of those agreements in circulation contain requirements for Air Products to undertake a schedule of condition and a baseline environmental survey before taking occupation of the land. Air Products' yield up obligations under the lease(s) granted pursuant to the option agreements being negotiated will be linked to the surveys undertaken. Whether or not possession is taken pursuant to a lease or pursuant to Article 31, it is the undertaker (the Applicant or Air Products as applicable) who would be responsible for demonstrating that the land has been appropriately restored and the landowner would have the right to approve that the restoration is to their reasonable satisfaction. The land used for Work No. 9 is expected to be returned to the landowners after completion of Phase 1 of the Project – anticipated to be within 6 months of Phase 1 commissioning or as agreed with landowners.
Q1.13.3.3	

Question	Response
Access to Laporte Road Temporary Construction Area What assessment has been undertaken in respect of proposed temporary access P (to Work No. 9) from both a highway safety perspective and its proximity to other accesses along Laporte Road.	A design has been prepared for the junction in accordance with the Design Manual for Roads and Bridge ("DMRB"), specifically CD 123 – Geometric design of at-grade priority and signal-controlled junctions. The design ensures that that the junction layout can safely accommodate all anticipated vehicle manoeuvres and movements and has a visibility splay in accordance with the proposed speed reduction to 30mph on Laporte Road. Traffic flows at this point are modest as are traffic movements in and out of the site. As a result, there will be no adverse interaction with the PDPS access opposite, or any other accesses on Laporte Road. Furthermore, as set out in **Section 2.9** of the **Outline Construction Traffic Management Plan [APP-223]** advance warning signage will be erected on the public highway prior to the temporary construction compound site entrances.
Q1.13.3.4	
Question	**Response**
Construction Compounds for Work Nos. 5 and 7 In relation to Work Nos. 5 and 7, confirm that the construction compounds would be contained within these areas and that sufficient land has been included within the Order Limits to allow for this. Also, confirm what has been assessed in the ES in relation to these elements.	The sizing, layout and requirements of the temporary construction compounds have been assessed based on the forecasted numbers and timing of workers at the site. The temporary construction compounds will be wholly contained within the footprints of Work Nos. 5 and 7, as stated in **Environmental Statement ("ES") Chapter 2: The Project [APP-044] Paragraph 2.5.6**, with additional car parking space included as part of Work Nos. 8 and 9. Sufficient land is included within Work Nos. 5 and 7 within the Order Limits for these temporary construction compounds. The use of temporary construction areas, including the use of Work Nos. 5 and 7 for this purpose, forms part of the Project description set out in **ES**

	Chapter 2: The Project [APP-044]. This Chapter forms the basis of the Project used for all of the technical assessments within the **ES**.
Q1.13.3.5	
Question	**Response**
Work Nos. 8 and 9 ES [APP-044, Paragraphs 2.5.8 and 2.5.19] state that Work Nos. 8 and 9 will be reinstated post construction, however additional details are requested regarding the future land use of Work Nos. 8 and 9 once they have been reinstated. Does the land have potential to be used for landscaping or other enhancement post construction?	The Environmental Statement assumes that both of these areas, which are only required for temporary construction areas, would be restored as follows: Work No. 8 is the Temporary Construction Area ("TCA") on Queens Road and will be used during Phase 1 of construction (and potentially during construction of subsequent phases of the Hydrogen Production Facility), then restored to its current use and returned to the existing owner. Work No. 9 is the TCA of Laporte Road and, at the end of construction Phase 1 (Year 1 – Year 3), this would be restored to agricultural use and returned to the existing owners. Given that these areas are only required for construction phases, it would not be necessary or appropriate to seek to use these areas of land for landscaping or other enhancement post construction.
Q1.13.3.6	
Question	**Response**

Alternatives What alternative locations for construction compounds were considered, prior to the identification of the selected locations and why were these locations discounted.	The Applicant assumes that the reference here is to Work No 8 and 9. Alternative construction compounds were not considered. These two sites were selected as they are immediately adjacent to the works being undertaken, so minimising vehicle trips associated with people and goods, reducing the burden on the local highway network, improving workforce efficiency and reducing costs. For example, the Laporte Road Temporary Construction Area (Work No.9) provides a temporary laydown area for the storage of equipment and materials related to the construction of the jetty, the ammonia tank and pipelines: all elements of the Project that are close to this construction compound. The area for Work No. 8 is in the ownership of the Applicant and an agreement with the owners for the temporary use of Work No. 9 is under discussion.
Q1.13.4 Impacts from Construction	
Q1.13.4.1	
Question	**Response**
Temporary Road Closures ES [APP-044, Paragraph 2.5.32] states that "Temporary closure will be required for the construction of all of the temporary and permanent accesses required for the Project to construct the accesses". It then refers the reader to Paragraph 2.5.22 [APP-044], which refers to overhead lines and not matters of temporary closure. Paragraph 2.5.35 [APP-044] provides detail on overnight closures on Laporte Road, Queens Road and Kings Road to allow for large construction	a) The Applicant is currently in discussion with North East Lincolnshire Council ("NELC") about the temporary closures and implications on the wider highway network. However, other than Work No. 4 there are not expected to be any full closures of the public highway. The **Outline Construction Traffic Management Plan [APP-223]** sets out (at Section 6) the processes that will be followed in terms of notification and liaison with stakeholders, including Royal Mail, Network Rail and local

plant to access the site.

a) The Applicant is asked to provide further clarity on what temporary closures are required, for how long and at what stages of the Proposed Development. Confirm if these temporary closures have been discussed and agreed with the LHA, local stakeholders and local residents. What mitigation measures in the form of diversion routes are proposed.

b) Does the LHA have any views on the temporary closures and potential implications for the wider highway network.

residents.

Details of the temporary road closures are set out in **Table 1:** Expected temporary road closures

Location	Purpose	Full / partial	Duration	Comments	Phase	Diversions
Laporte Road	Culvert construction	full	Up to 4 weeks	Full closure to construct underground culvert. Diversion in place	1	Diversion via Kiln Lane, A1173 and Queens Road
Laporte Road	Work No. 9 temporary entrance	partial	2 weeks	Lane closure to facilitate entrance construction. Traffic light control	1	n/a
Laporte Road	Work No. 2 permanent entrance	partial	2 weeks	Lane closure to facilitate entrance construction. Traffic light control	1	n/a
Laporte Road	Work No. 3 temporary entrance	partial	2 weeks	Lane closure to facilitate entrance	1	n/a

				construction. Traffic light control		
Laporte Road	Work No. 3 permanent entrance	partial	2 weeks	Lane closure to facilitate entrance construction. Traffic light control	1	n/a
Laporte Road	Work No. 5 temporary entrance	partial	2 weeks	Lane closure to facilitate entrance construction. Traffic light control	1	n/a
Laporte Road	Utility Tie ins	partial	2 weeks per connection	Work by Utility providers. Lane closure to facilitate utility connections Traffic light control	1	n/a
Queens Road	Work No. 7 permanent entrance	partial	2 weeks	Lane closure to facilitate entrance	1	n/a

				construction Traffic light control		
Queens Road	Work No. 7 permanent entrance	partial	2 weeks	Lane closure to facilitate entrance construction. Traffic light control	1	n/a
Queens Road	Utility Tie ins	partial	2 weeks per connection	Work by Utility providers. Lane closure to facilitate utility connections Traffic light control	1	n/a
A1173	Work No. 7 permanent entrance	partial	2 weeks	Lane closure to facilitate entrance construction Traffic light control	1	n/a
A1173	Work No. 7 temporary entrance	partial	2 weeks	Lane closure to facilitate entrance	1	n/a

				construction Traffic light control		
Kings Road / Queens Road / Laporte Road	Abnormal load transportation	Overnight full closure approximately 23:00-06:00	Overnight / multiple	Temporary / overnight road closure to facilitate movement of oversize equipment to site	1, 2, 3, 4, 5, 6	n/a

A meeting was held on 21 April 2023 where temporary closures were discussed at a high level. Further to that a meeting was held on Friday 8th March 2024 with NELC at which the areas of permanent stopping up (of verges) along Laporte Road, the proposed reduction in speed limit and start point of the Bridleway 36 diversion were discussed and an agreement is expected to be reached in due course.

The temporary Traffic Regulation Orders, as set out in Parts 2 and 3 of the DCO, along Laporte Road, Queens Road and Kings Road were not discussed and will be covered in future discussions.

Q1.13.4.2	
Question	**Response**
Traffic Management Measures	The traffic management measures that would be put in place to ensure that

ES [APP-044, Paragraph 2.5.38] refers to traffic management measures that would be put in place to ensure that traffic flows on the road network are maintained. Have these matters been discussed and agreed with the LHA. What discussions have taken place with existing operators/businesses?	traffic flows on the road network are maintained are as follows: • Temporary traffic lights will be installed on Laporte Road, as set out in Part 4 of Schedule 10 of the **draft Development Consent Order ("DCO") [PDA-004]**, and these would be used for partial road closures (to construct site accesses, for example) or if materials or large equipment needed to be moved from temporary facilities in Work Plan 5 or 9 across Laporte Road. • Other measures would be installed as required in accordance with the Traffic Signs Manual Chapter 8: Traffic Safety Measures and Signs for Road Works and Temporary Situations (Department for Transport, 2009). These could include appropriate signage and segregated working areas, with the aim of ensuring the safety of the workforce. **Discussions with the local highway authority** A meeting was held with North East Lincolnshire Council ("NELC"), the local highway authority, on 21 April 2023. The purpose of the meeting was to discuss (i) the proposed locations of the temporary and permanent access positions, (ii) a reduced speed limit on Laporte Road and (iii) the proposed temporary road closures. Following the meeting, comments made by Officers were used to develop the Traffic Regulation Measures, as set out in Schedule 10 Parts 1 to 4 of the **draft DCO** as well as the permanent and temporary accesses as appropriate. A meeting was held on Friday 8th March 2024 with NELC at which the areas of permanent stopping up (of verges) along Laporte Road, the proposed reduction in speed limit and start point of the Bridleway 36 diversion were discussed and an agreement is expected to be reached in due course.

	The temporary Traffic Regulation Orders, as set out in Parts 2 and 3 of the DCO, along Laporte Road, Queens Road and Kings Road were not discussed and will be covered in future discussions. It should be noted that the only temporary road closure relates to the culvert construction on Laporte Road, which is expected to take two to four weeks. Any other works in the public highway required to form access junctions, etc., would only require a partial closure for around two weeks with the use of temporary traffic lights to control traffic movements. **Discussions with existing operators/businesses** Discussions with other parties about traffic management measures have been undertaken as follows: • PD Ports Limited in their Relevant Representation **[RR-024]** commented on traffic management measures around Laporte Road, in particular any planned closure, as well as details of the proposed temporary access opposite their existing access; a full response has been prepared to the issues raised and submitted as part of the **Applicant's Responses to Relevant Representations [TR030008/EXAM/9.2]**. • Royal Mail in their Relevant Representation **[RR-025]** sought clarification of how they will be informed of traffic management measures on the local highway network. In response a paragraph has been added to **Section 6** of the **Outline Construction Traffic Management Plan [APP-223]** setting out the measures that will be taken to keep Royal Mail informed of any construction activities, including but not limited to, road closures, diversions and works to the highway, with at least one months' notice being given of any activity that has the potential to impact their operations.

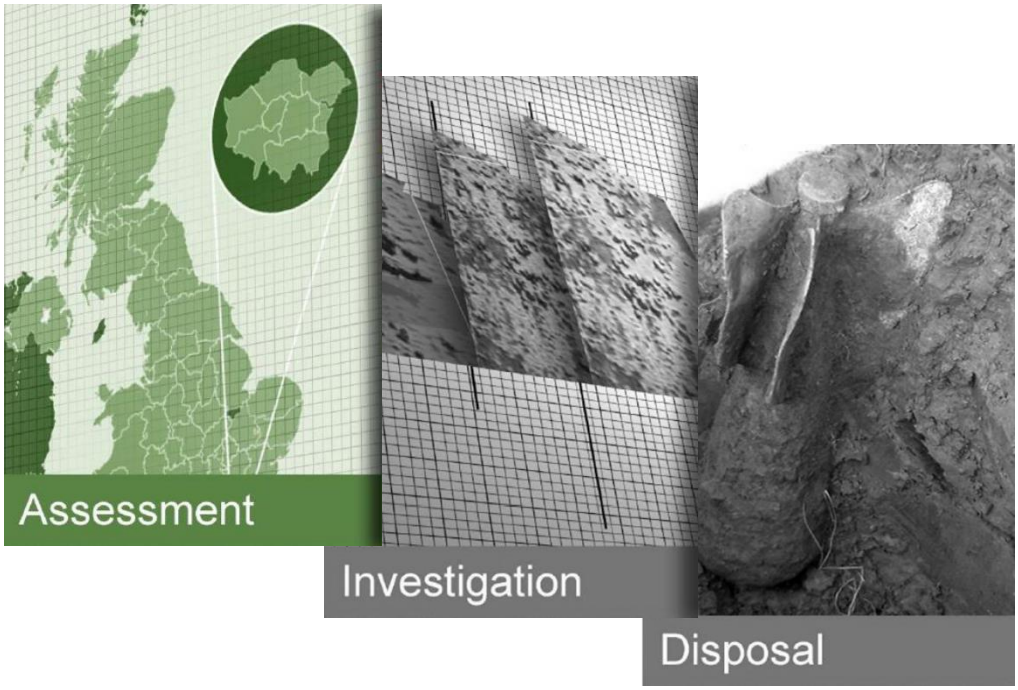
Q1.13.4.3	
Question	**Response**
Long Strip Explain and justify the method of construction to be used for the installation of the pipelines within Long Strip. If HDD is not to be used, explain and provide reasons for why not.	The ammonia pipelines and jetty utilities will be installed on pre-assembled piperacks in Work No. 2, through the Long Strip. The piperacks will be placed on concrete foundations, which may require piles. To minimise impact on the Long Strip, the pipeline route will offset into Work No. 5, as the route approaches Laporte Road. The design of Work No. 2 allows space for a similar piperack for future CO_2 imports. The main reasons why this "above ground design" was selected rather than "below ground horizontal directional drilling (HDD)" are: • The construction methodology for HDD requires the drill to pass from one end to the other (e.g. sea wall to ammonia tank area) and then a pipe sleeve to be pulled back through the bore (ammonia tank area to sea wall), in a single motion, before the bore is stable. This requires space the same length as the bore to be available in a straight line to lay out the pipe sleeve before pulling it back through the bore. This space is not available and therefore HDD is not technically viable. • The working area required for the HDD drilling rigs is large and would result in more impact to the Long Strip at the sea wall end than the "above ground design".
Q1.13.4.4	
Question	**Response**

Construction traffic ES [APP-048, Paragraph 6.8.38] identifies that there is anticipated to be an annual daily average of 412 two-way construction-related LDV movements and 90 two-way HDV movements on Cleethorpe Road, Grimsby. Clarify where this traffic is coming from	The Light Duty Vehicle ("LDV") traffic is related to the construction phase and represents workers residing within the residential areas of Grimsby and Cleethorpes. The Heavy Duty Vehicle ("HDV") traffic is related to construction phase traffic picking up materials from Grimsby Docks. Both LDV and HDV numbers relate to the proportion of construction traffic travelling on the A180 east of the A180 / A1173 junction. This is demonstrated in **Table 11-21: Construction Trip Assignment – Peak of Project Construction** (Link 1) within **Environmental Statement Chapter 11: Traffic & Transport [APP-053]**.
Q1.13.4.5	
Question	**Response**
Unexploded Ordnance RR-007 refers to the potential for Unexploded Ordnance in the area. Clarify whether any assessment has been undertaken within the Order Limits, and if so, submit it to the ExA. If not, justify why not.	An Unexploded Ordnance ("UXO") assessment was undertaken prior to the geotechnical work that was undertaken on the site. This comprised a desktop study and was undertaken for the whole site prior to the geotechnical work and indicated that the site is low risk for UXO. This is provided as **Appendix 1**.

3 Appendices to the Applicant's Responses to the Examining Authority's First Round of Written Questions

Appendix 1 – IGET UXO Desk Study Immingham

zeticaUXO



Immingham - UXO Desk Study & Risk Assessment

Drafted by Matthew Eatough
Checked by Abi Newton
Authorised by Stefan Lang

Document Title	**UXO Desk Study & Risk Assessment**
Document Ref.	**P11863-22-R1**
Revision	**A**
Project Location	**Immingham**
Client	**AECOM**
Date	**2nd August 2022**

UXO DESK STUDY & RISK ASSESSMENT

EXECUTIVE SUMMARY

Key findings: No significant sources of Unexploded Ordnance (UXO) hazard have been identified. The potential for UXO to migrate onto the Site due to marine processes cannot be discounted.

Key actions: UXO awareness briefing for staff involved in dredging. Explosive Ordnance Clearance (EOC) Engineer attendance aboard the dredger may be prudent.

UXO Hazard Assessment

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

Given this, it is considered that the Site has a low UXO hazard level, as shown in the following Figure, reproduced as Figure 6 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P11863-22-R1-MAP01-A.

It should be noted that the possibility of smaller, lighter items of UXO migrating onto the Site cannot be totally discounted, this forms part of the low background risk of encountering UXO on any similar site in the UK.

UXO hazard zone plan of the Site

Source: OpenStreetMap *Not to Scale*

Legend	Very Low	Low	Moderate
	High	Very High	Site boundary

The main findings of the report are summarised below.

- No records of bombing or military activity on the Site during World War One (WWI) have been found.

- During World War Two (WWII) the main strategic targets in the vicinity of the Site included Immingham Dock, Royal Navy (RN) establishments, transport infrastructure, and military camps and depots.
- Records indicate that several Anti-Aircraft (AA) and anti-invasion defences were established in the vicinity of the Site. These were removed post-WWII.
- No records have been found indicating that the Site was bombed during WWII. Records indicate that the nearest High Explosive (HE) bomb fell approximately 0.9km southeast of the Site on the 29th May 1942.
- No records of military activity on the Site post-WWII have been found.

Data Confidence Level

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

Proposed Works

It is understood that works on the Site are associated with the development of new ammonia import terminal at the Port of Immingham. This includes the construction of a new jetty, along with accompanying pipeline and storage tank areas within existing port infrastructure.

For the purpose of this risk assessment, it is assumed that works on the Site may include dredging, intrusive ground investigations, excavations and piling.

Risk Assessment

The Table below, reproduced as Table 4 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the methodology for the risk assessment are provided in Section 8.2 of the main report.

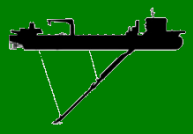
UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Dredging	1	1	1	1	5	5	Low
	Shallow Excavations	1	1	1	1	5	5	Low
	Deep Excavations	1	1	1	1	5	5	Low
	Boreholes/Piling	1	1	1	1	5	5	Low
Other UXO	Dredging	1	1	1	1	5	5	Low
	Shallow Excavations	1	1	1	1	4	4	Low
	Deep Excavations	1	1	1	1	4	4	Low
	Boreholes/Piling	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)								
Shallow Excavations defined as <1.0m below ground level (bgl.)								

Risk Mitigation Plan

The Table below, reproduced as Table 5 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.

Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Dredging		**UXO awareness briefing** – It is recommended that those involved in dredging operations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find. Procedures for an Emergency Response Plan (ERP) in the event of a UXO find should also be established. **EOC Engineer** – If additional comfort is required, an Explosive Ordnance Clearance (EOC) Engineer can be present aboard the dredger during operations.
Excavations		**Proceed with works** – if additional comfort is required to address the residual UXO hazard on onshore areas, a formal UXO awareness briefing can be provided.
Boreholes/Piling		**Proceed with works**

In summary, it is recommended that staff involved in dredging operations are provided with a formal awareness briefing so that they take appropriate action in the event of a suspect find. For additional comfort, an EOC Engineer can be present aboard the dredger and take appropriate action in the event of a suspect item being encountered.

What Do I Do Next?

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

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

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

CONTENTS

Figures, Plates & Tables

Accompanying GIS Data

P11863-22-R1-MAP01-A (UXO Desk Study)

ABBREVIATIONS

AA	Anti-Aircraft
ALARP	As Low As Reasonably Practicable
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
BDU	Bomb Disposal Unit
CMD	Conventional Munitions Disposal
DEMS	Defensive Equipped Merchant Ships
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FFE	Free From Explosives
HAA	Heavy Anti-Aircraft
HE	High Explosive
HMT	His Majesty's Trawler
HMS	His Majesty's Ship
HSE	Health and Safety Executive
HQ	Headquarters
IB	Incendiary Bomb
IED	Improvised Explosive Device
IEDD	Improvised Explosive Device Disposal
JSEODOC	Joint Services EOD Operations Centre
LAA	Light Anti-Aircraft
LG	Lewis Gun
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
PUCA	Pick Up and Carry Away
RAF	Royal Air Force
RNAS	Royal Naval Air Station
RN	Royal Navy
TEP	Time Expired Pyrotechnics
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
WWI	World War One
WWII	World War Two

UXO DESK STUDY & RISK ASSESSMENT

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

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

1 INTRODUCTION

1.1 Project Outline

Zetica Ltd was commissioned by AECOM to carry out a detailed Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an area of approximately 104 hectares (ha) at the Port of Immingham in Lincolnshire (the 'Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry' and C754 'Assessment and Management of Unexploded Ordnance (UXO) Risk in the Marine Environment'.

Where appropriate, this hazard assessment includes:

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

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

1.2 Sources of Information

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

1.2.1 Zetica Ltd Defence Related Site Records

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

1.2.2 Zetica Ltd Bombing Density Records and Maps

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

1.2.3 Ministry of Defence and Government Records

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

1.2.4 Other Historical Records, Maps and Drawings

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

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

1.2.5 Local Authority Records

Information was obtained from the North East Lincolnshire Archives.

1.2.6 Local Record Offices and Libraries

The Immingham Museum & Heritage Centre and Grimsby Library were consulted for records.

1.2.7 Local Historical and Other Groups

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

1.3 Data Confidence Level

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

2 THE SITE

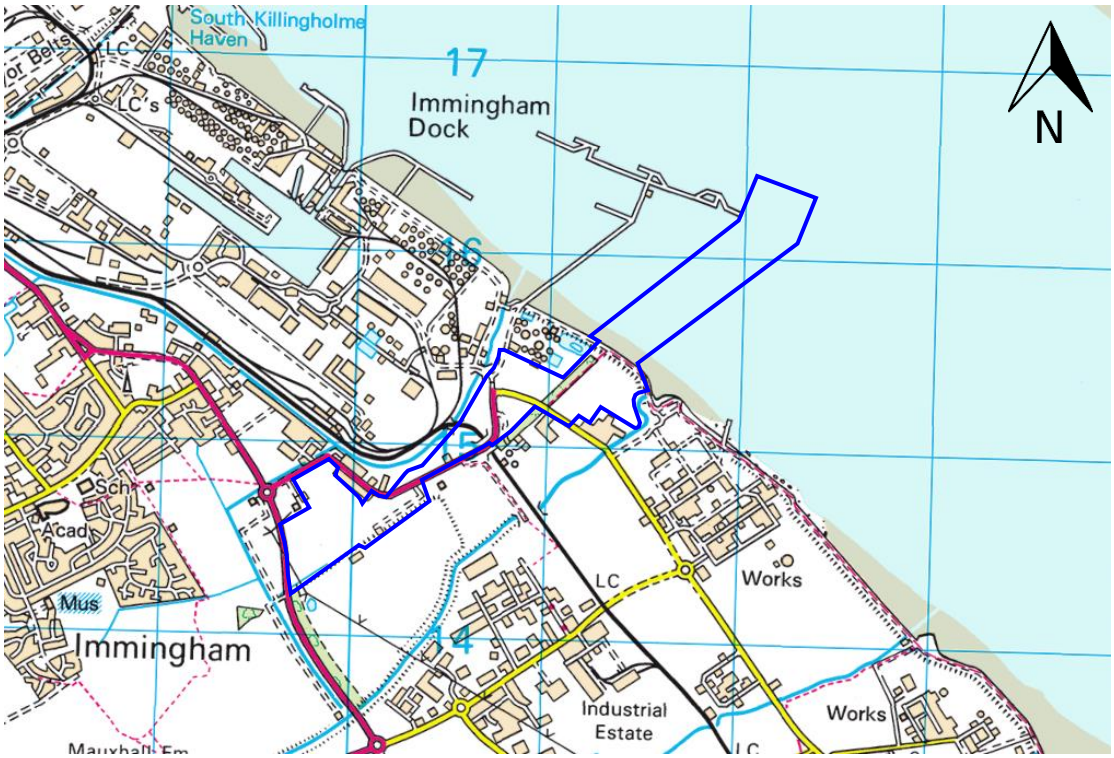
2.1 Site Location

The Site is centred on Ordnance Survey National Grid Reference (OSNGR) TA 207151. It is located at the Port of Immingham, approximately 2.5km east of central Immingham.

The Site comprises hardstanding, open ground, several commercial and industrial premises, and an area encompassing the Humber Estuary. It is bounded to the north by the Humber Estuary, to the east by open ground, industrial premises and the Humber Estuary, and to the south and west by open ground, and commercial and industrial premises.

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

Figure 1 Site location map



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

Legend	Site boundary

Plate 1 Recent aerial photograph of the Site

Source: Google Earth *Not to Scale*

Legend	Site boundary

3 MILITARY ACTIVITY

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

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

3.1 Defences

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

- Anti-Aircraft Guns
- Anti-Invasion Defences
- Barrage Balloons
- Bombing Decoys
- Home Guard
- Mined Locations
- Mortar & Gun Emplacements
- Pillboxes

The nearest military defences to the Site are described below.

3.1.1 Barrage Balloons

Given the strategic importance of Immingham, Kingston-upon-Hull, and the Royal Navy (RN) facilities on the Humber, extensive barrage balloon defences were established in the vicinity of the Site during WWII.

Barrage balloons were widely used in Britain's defence against the Luftwaffe. Balloons were made of panels of fabric sewn or glued together and inflated using hydrogen. 6No. cables were typically attached to the balloon and joined to a single cable which ran to a winch used to control the balloon's height.

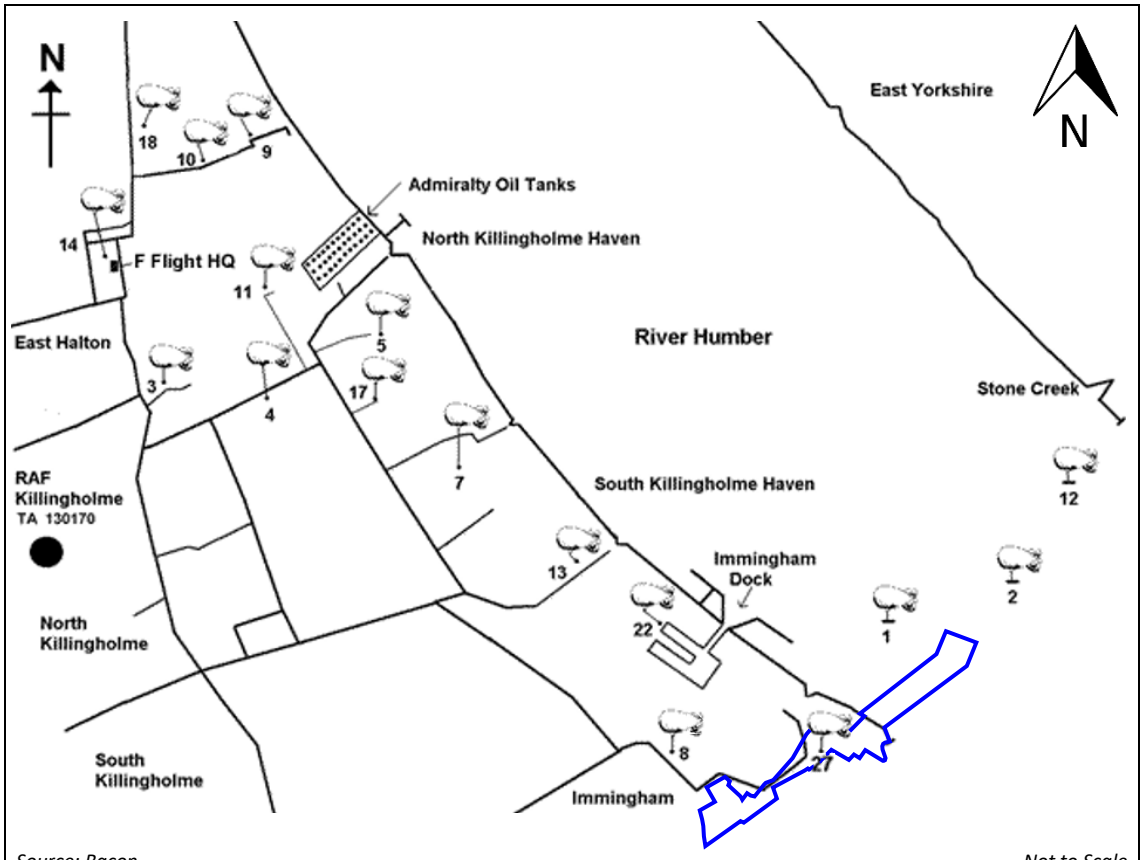
There was a small amount of explosive charge 150 feet (ft) from each end of the balloon cable. If a balloon was hit by an aircraft this would ignite and the cable, which had a parachute on each end, would cause the plane to crash.

Records indicate that the nearest barrage balloon anchorage (No. 27) was located at Long Strip, Immingham (TA 208152), on the central part of the Site. This has also been identified in Plate 3 (see Section 4.2).

Immingham's barrage balloons were operated by units of 'F' Flight, No. 942 (East Riding) Balloon Squadron. Each anchorage typically had associated accommodation nearby for crew, as well as a Small Arms Ammunition (SAA) store.

Figure 2 is a map showing the barrage balloon defences in the vicinity of the Site during WWII.

Figure 2 Map of barrage balloon defences in the vicinity of the Site during WWII



Source: Bacon *Not to Scale*

Legend	Site boundary

In August 1944, when the threat of enemy air raids in the area had receded, No. 942 Squadron was disbanded and the barrage balloon anchorages in the vicinity of the Site were abandoned.

Potential UXO Hazard

Any SAA store associated with the anchorage would likely have been removed in 1944 along with the balloon, although the potential that ammunition was disposed of in close proximity to the Site cannot be totally discounted.

SAA is not considered to provide a significant UXO hazard (see Appendix 1).

Barrage balloons are not considered to provide a source of UXO hazard to the Site.

3.1.2 Anti-Aircraft Guns

During WWI there were 5No. Anti-Aircraft (AA) batteries within 10km of the Site. The nearest was located at Immingham (TA 187142), within approximately 0.8km of the Site.

This was armed with 2No. 1-pounder (pdr) guns in 1916, and an additional 12-pdr 12-hundredweight (cwt) gun in 1917. Records indicate that these armaments were situated on travelling carriages, which were likely moved around as operational requirements dictated.

During WWII there were 19No. Heavy AA (HAA) within 10km of the Site. The nearest was located at Long Strip, Immingham (TA 210155), approximately 0.1km from the Site. Its armament is unknown.

During WWII Immingham Dock was defended by multiple Light AA (LAA) gun emplacements, located within approximately 0.2km of the Site.

These initially comprised 24No. Lewis Guns (LG), with an additional 4No. 40mm Bofors guns listed in May 1943. They were manned by units of 309th Battery, 39th Regiment LAA. All LAA gun emplacements at Immingham were removed at the end of WWII.

The nearest recorded WWII AA shell incident to the Site is described below.

20th May 1942

2No. AA shells fell on Immingham Dock, approximately 0.8km west of the Site.

Potential UXO Hazard

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

Ammunition stores associated with HAA and LAA gun batteries were typically removed when the positions were dismantled at the end of WWII, although the possibility of local munitions disposal around defended positions cannot be totally discounted.

3.1.3 Pillboxes

During WWII, several pillboxes were established in the vicinity of the Site, forming part of the region's anti-invasion defences. The nearest was located near the foreshore of Immingham Dock (TA 207158), approximately 0.3km west of the Site.

Records indicate that this was a FW3/23 type 3-bay pillbox. It was manned by units of the Home Guard (see Section 3.2.3). It was removed post-WWII.

Potential UXO Hazard

Pillboxes often had associated munitions caches which may have stored Small Arms Ammunition (SAA), in addition to close combat munitions such as grenades and mortars.

These caches were typically removed at the end of WWII, although the possibility of local munitions disposal around defended positions cannot be totally discounted.

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

3.2.4 Home Guard

During WWII, the 7th Lindsey (Grimsby Rural) Battalion of the Home Guard operated in the vicinity of the Site. The Home Guard was responsible for patrolling local transport links and strategic targets such as Immingham Docks, as well as manning regional anti-invasion defences later in the war.

Potential UXO Hazard

It should be noted that records of Home Guard activities were rarely kept, and training activities were usually unofficial or unsanctioned.

Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often buried or dumped in ad-hoc locations.

Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

3.1.5 Bombing Decoys

The nearest recorded bombing decoy was located at Immingham Range (TA 234136), approximately 2.4km east-southeast of the Site.

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

3.2 Military Airfields

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

- Military Airfields

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

During WWI, Royal Naval Air Station (RNAS) Immingham was established at the southeast corner of Immingham Dock (TA 197155), approximately 0.3km west of the Site. This base was used as a kite balloon station for RN convoy's operating out of Immingham Dock (see Section 3.6.1).

Records indicate that the base comprised 2No. balloons, which were operated from 2No. canvas balloon sheds. The station was serviced by a small technical area, which contained an armoury. This is highlighted on Figure 3, a plan of RNAS Immingham, dating from circa 1918.

Figure 3 Plan of RNAS Immingham, c. 1918

Source: The National Archives *Not to Scale*

Legend	Site boundary	Station boundary
	Balloon sheds	Technical area

In April 1918, the station was acquired by the newly formed Royal Air Force (RAF), becoming No. 8 Balloon Base. It was decommissioned in 1919, and all associated facilities were subsequently removed.

During WWII the nearest operational airfield was RAF North Killingholme (TA 130170), approximately 6.3km west-northwest of the Site. It opened in November 1943 under RAF Bomber Command and was home to No. 550 Squadron, flying Avro Lancaster heavy bombers.

RAF North Killngholme remained operational until October 1945, when it was closed. The land was subsequently reverted to agricultural use.

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

3.3 Aircraft Crashes

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

- Aircraft Crashes

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

3.4 Explosives Factories, Munitions Depots and Disposal Areas

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

- Explosives Factories
- Munitions Depots
- Munitions Disposal Areas

No records of any explosives factories, munitions depots or munitions disposal areas on the Site have been found. The nearest is described below.

3.4.1 Immingham Depot

In the spring of 1917, a salvage depot was established at Immingham (TA 196164), within approximately 1km west of the Site. This was tasked with the sorting and salvage of used material from the western front, primarily fired brass cartridge cases.

Various types of shells and boxes were sorted and categorised at the depot, before being transported inland for repair and rectification. By the end of the war, the depot had sorted 3,314,690No. cartridge cases for salvage.

Immingham Dock was also used for the storage and distribution of various naval munitions, primarily sea mines and torpedoes. Records indicate that over 130,000No. tons of sea mines were stored and distributed from Immingham during WWI. It is considered likely that the wool transit shed (TA 201157), approximately 0.6km west of the Site, was used for this purpose.

Immingham Depot closed at the end of WWI, and all facilities were returned to commercial use.

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

3.5 Firing Ranges and Military Training Areas

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

- Artillery Ranges
- Bombing Ranges
- Military Training Areas
- Small Arms Ranges

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

3.6 Other Military Establishments

No other military establishments have been identified on the Site. The nearest is described below.

3.6.1 Immingham Dock

During WWI, a naval base was established at Immingham Dock (TA 196160), within approximately 0.6km west of the Site. Established in August 1914, the base was designated as the Headquarters (HQ) of the 7th Destroyer Flotilla. This comprised a main force of 11No. torpedo boat destroyers.

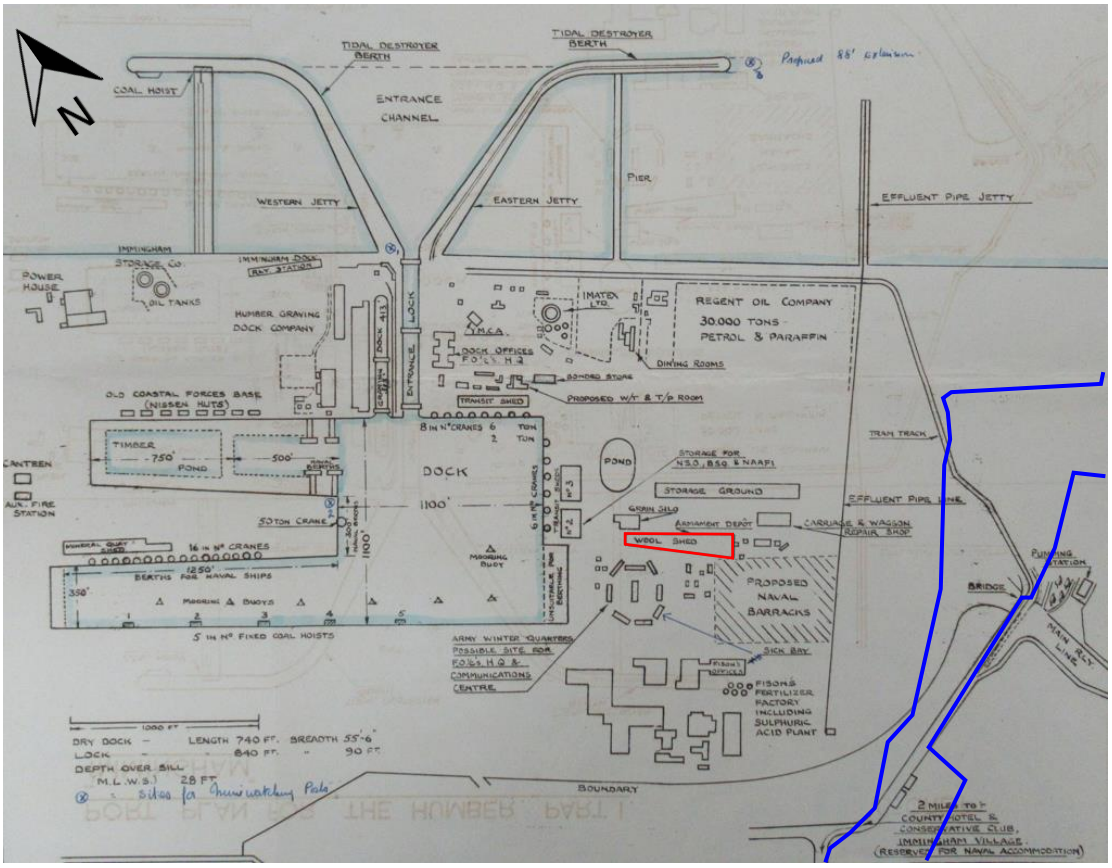
The dock was also home to a small fleet of British C-class and D-class submarines, belonging to the 2nd, 3rd and 6th Submarine Flotillas. As a sub-command of the Admiral of Patrols, the units stationed at Immingham were tasked with coastal defence, and were used to combat enemy U-boat action in the North Sea.

At the end of WWI, the naval facilities at Immingham Dock were briefly amalgamated under the command of His Majesty's Ships (HMS) Pembroke VII and VIII. In 1921 the base was decommissioned.

At the outbreak of WWII, Immingham Dock was re-established as a naval base, and was designated as the RN's HQ for the Humber. Records indicate that the base was home to a small fleet of torpedo boats, minelayers and minesweepers. These were tasked primarily with coastal defence and convoy protection duties.

Figure 4 is a plan of Immingham Dock, dating from circa 1944. This indicates that the wool transit shed (TA 201157), approximately 0.6km west of the Site, was used as an armament depot.

Figure 4 Plan of Immingham Dock, c. 1944



Source: The National Archives *Not to Scale*

Legend	Site boundary	Armament depot

At the end of WWII, the naval base was decommissioned, and all facilities returned to commercial use.

Potential UXO Hazard

It should be noted that RN activities at Immingham Dock were poorly documented.

Whilst it is considered to be unlikely, the potential that ordnance was disposed or scattered by RN personnel on the Site, cannot be entirely discounted.

Immingham Dock is not considered to provide a significant source of UXO hazard to the Site.

Details on UXO migration in the marine environment are presented in Section 5.

4 BOMBING

4.1 WWI Bombing

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

- WWI Bombing

No records have been found indicating that the Site was bombed during WWI. The nearest recorded incident is described below.

29th July 1916

Zeppelin L24 dropped 6No. High Explosive (HE) bombs on Stallingborough Marsh, near Immingham Halt Station, within approximately 0.3km east-southeast of the Site.

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

4.2 WWII Bombing

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

- WWII Bombing

No records have been found indicating that the Site was bombed during WWII. Details of WWII bombing in the vicinity of the Site are provided in the following sections.

4.2.1 Bombing in Humberside & Immingham

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe who were building up a photographic record of potential targets. As early as 1937, German aircraft were flying up the Humber Estuary to photograph docks and factories.

Some areas of Humberside were heavily bombed during WWII, particularly Kingston-upon-Hull and Grimsby. The Humber Estuary was a major navigational aid for German bombers heading inland, and air activity in the region was particularly intensive.

Bombing raids in the region began in the summer of 1940 and continued until the end of WWII. Some smaller targets in the region were specifically targeted, including the Admiralty Fuel Depot at Killingholme (TA 180177), approximately 3km northwest of the Site.

Despite being a major strategic target, the Port of Immingham escaped significant bombing during WWII. Luftwaffe attacks in the immediate vicinity of the Site were primarily contained to 'tip and run' bombing raids.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may also under-represent the number and frequency with which bombs fell in rural areas.

4.2.2 Strategic Targets

The Site was located in an area which contained numerous potential strategic targets, including Immingham Docks, RN establishments, transport infrastructure, and military camps and depots.

Plate 3 is a Luftwaffe target photograph of the Port of Immingham, dated the 3rd September 1940.

This shows Immingham Dock (GB 45 27), adjacent to the Site, and Immingham Dock Granary (GB 56 26), approximately 0.8km west of the Site.

AA guns and searchlight batteries are marked as 'Flak' and 'Scheinw' respectively.

Possible bomb cratering has also been identified (marked 'a').

Plate 2 Luftwaffe target photograph of the Port of Immingham, 3rd September 1940

Source: NARA *Not to Scale*

Legend	Site boundary

4.2.3 Bombing Densities and Incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal or Metropolitan Boroughs (MB) and County Boroughs (CB). WWII bomb density levels are defined below:

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

5-15 bombs per 405ha is Low.

15-50 bombs per 405ha is Moderate.

50-250 bombs per 405ha is High.

>250 bombs per 405ha is Very High.

Table 1 Bombing statistics

Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)
Grimsby RD	**204**	**6**	**0**	**210**	**5.3**
Cleethorpes MB	69	2	0	71	33.2
Grimsby CB	131	0	0	131	24.0
Glanford Brigg RD	663	12	1	676	4.9
Caistor RD	195	1	0	196	1.6

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

Details of the nearest recorded bombing incidents to the Site are given in the following section.

20th June 1940

Several High Explosive (HE) bombs (number unspecified) fell on open fields between Stallingborough and Immingham town, within approximately 1km south of the Site.

29th May 1942

Several IBs fell near Immingham town, within approximately 0.7km southwest of the Site.

4No. 500kg HE bombs fell on mud of the Humber Estuary Foreshore, within approximately 0.9km southwest of the Site.

11th August 1942

Several IBs fell on and near the marshalling yards at Immingham Dock, within approximately 0.7km west of the Site.

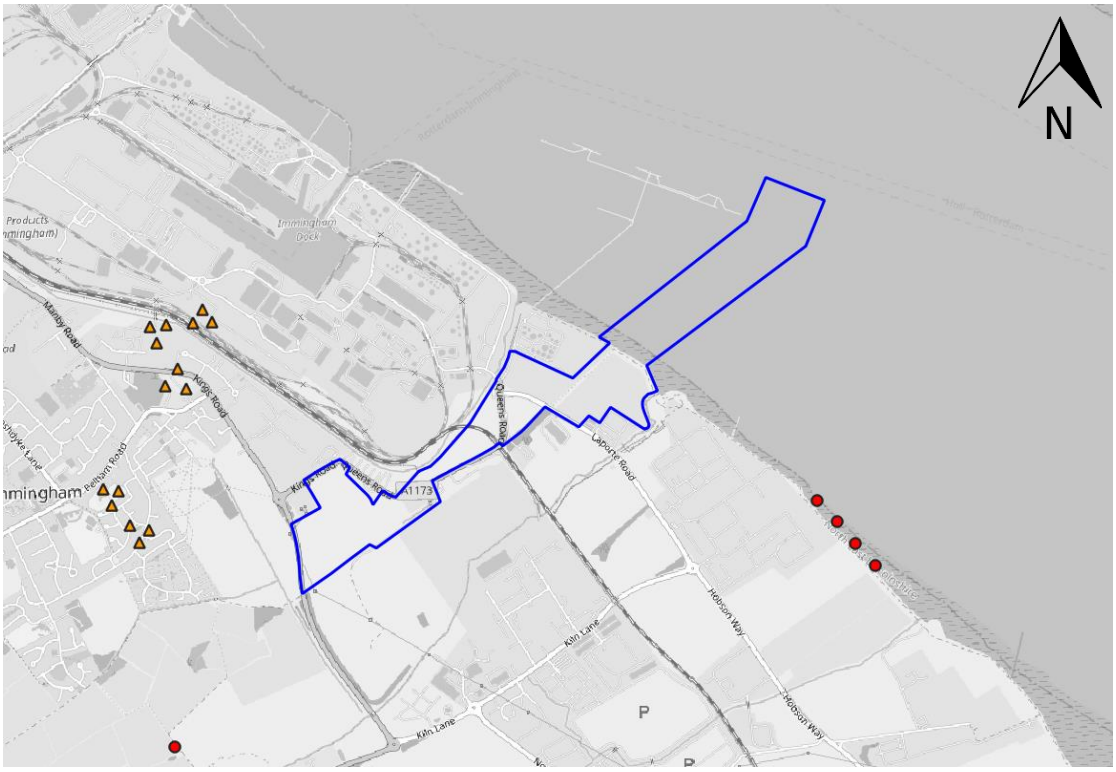
It should be noted that during WWII, many Unexploded Bombs (UXB) were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXB were probably removed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

Figure 5 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

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

The bomb map is also given in the accompanying P11863-22-R1-MAP01-A.

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



Source: OpenStreetMap *Not to Scale*

Legend	Site boundary	HE bomb	IBs

Plate 3 is an aerial photograph of the central and north-eastern part of the Site, dated the 29th April 1947. No bomb damage or cratering has been identified on or in close proximity to the Site.

Barrage balloon anchorage No. 27 has been identified on the Site (see Section 3.1.1).

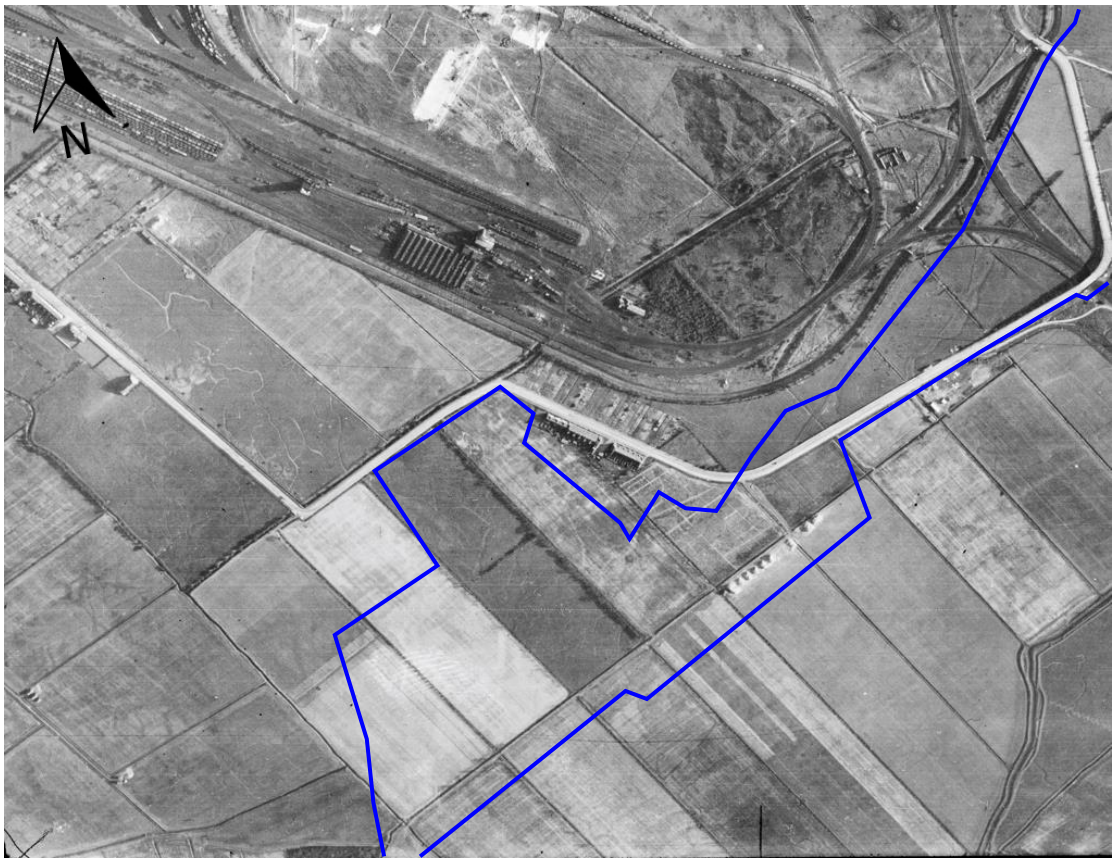
Plate 3 Aerial photograph of the central and north-eastern part of the Site, 29th April 1947

Source: Historic England *Not to Scale*

Legend	Site boundary	Barrage balloon anchorage

Plate 4 is an aerial photograph of the southwestern part of the Site, dated the 29th April 1947. No bomb damage or cratering has been identified on or in close proximity to the Site.

Plate 4 Aerial photograph of the southwestern part of the Site, 29th April 1947



Source: Historic England *Not to Scale*

Legend	Site boundary

Potential UXO Hazard

No records have been found indicating that the Site was bombed and no bomb damage has been identified on the Site on historical aerial photography.

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

4.2.4 Geology and Bomb Penetration Depths

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

British Geological Survey (BGS) 1:50,000 Sheet 81 Patrington (Solid & Drift) and BGS borehole records from on and near the Site were consulted to get an indicative overview of the Site geology.

The geology of the landward part of the Site is understood to consist of Made Ground, over Tidal Flat Deposits of clay and silt, overlying the Flamborough Chalk Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the landward part of the Site assuming WWII ground conditions of 1m of topsoil (modelled as soft clay), over 14m of clay and silt, overlying more than 20m of weak rock.

Table 2 Estimated average maximum bomb penetration depths (landward part of the Site)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	7.5m
	250kg	11.0m
	500kg	17.5m

The geology of the marine part of the Site is understood to consist of water, over Beach and Tidal Flat Deposits of clay and silt, overlying the Flamborough Chalk Formation.

Table 3 provides an estimate of average maximum bomb penetration depths for the marine part of the Site assuming a water column of 5m (modelled as soft clay), over 35m of clay and silt, overlying more than 20m of weak rock.

Table 3 Estimated average maximum bomb penetration depths (marine part of the Site)

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	7.0m
	250kg	11.0m
	500kg	18.5m

Vertical or near vertical deployment of ordnance to the Humber Estuary bed is unlikely due to deflection of UXB at the water surface and the initial aerial trajectory of air-delivered ordnance.

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

It penetrates with less impact velocity and momentum.

For parts of the Site located in deeper water penetration depths are likely to be less than the theoretical ones given in Table 3.

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

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

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

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

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

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

e) That the soil type is homogenous.

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

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

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

5 UXO IN THE MARINE ENVIRONMENT

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

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

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

Potential sources of UXO hazard in the marine environment in the vicinity of the Site are described below.

5.1 Immingham Dock

During WWI and WWII Immingham Dock, within approximately 0.6km west of the Site, was used as a naval base by the RN. Further information is given in Section 3.1.6.

The possibility of ammunition and other ordnance spillage into the marine environment during rearmament of naval vessels at moorings cannot be entirely discounted. Such spillage may include, for example, SAA and pyrotechnic marker devices.

5.2 AA Defences

Immingham and the Humber Estuary had extensive AA defences during WWII (see Section 3.1.2).

These are likely to have contributed UXAA shells to the marine environment in the vicinity of the Site.

Given the number of HAA and LAA batteries and the strength of currents in the Humber area, it is considered that the potential for shells to migrate along the riverbed cannot be totally discounted.

5.3 Coastal Defences

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

The nearest was coastal battery during WWI was Stallingborough Fort (TA 222148), approximately 0.9km east-southeast of the Site. Established in February 1916, it was equipped with 2No. 6-inch (") breech-loading Mk. VII guns. This formed part of the Humber estuary's coastal defence system. In 1919 the guns were removed. The fort was abandoned in 1926.

During WWII Stallingborough Fort was reused and fitted with 2No. 4.7" quick-firing guns. 2No. searchlights for close defence were also installed. By 1945 it had become disused.

During WWI a supplementary coastal battery was established at Sunk Island (TA 249175), approximately 2.8km northeast of the Site. This was built between 1914 and 1915. Records indicate it comprised 2No. 6" breech-loading Mk. VII guns, along with command post, quarters, magazine and accompanying searchlights. In 1919 the guns were removed. The battery was abandoned in 1926.

In the summer of 1940 Sunk Island Battery was reused and fitted with 2No. 4.7" quick-firing guns and 2No. searchlights for close defence. By the end of WWII it had become disused.

No records have been found to indicate that the coastal batteries in the region conducted practice firing, but it is likely that some form of training was undertaken. The possibility that these contributed shells to the surrounding marine environment, in vicinity of the Site, cannot be entirely discounted.

5.4 Marine Ranges

No records of marine ranges or coastal batteries on or in close proximity to the Site have been found.

The nearest marine range to the Site was Grimsby Merchant Navy Range (TA 314079), approximately 12.2km southeast of the Site. Grimsby Merchant Navy Range was used for the training of Defensive Equipped Merchant Ships (DEMS), using 12-pdr guns, 20mm Oerlikon cannons, machine guns, and Unrotated Projectiles (UP).

Given the presence of marine ranges in the vicinity of the Site, the potential for UXO to migrate onto the Site, whilst unlikely, cannot be totally discounted.

5.5 Marine Mines

During WWI and WWII, major defensive and offensive minefields were established in the Humber estuary, within approximately 3km of the Site.

Given the importance of Immingham and the Humber Estuary, waters in the vicinity of the Site would have been regularly swept for mines. Despite this sweeping, a very real threat from mines remained throughout the war and at least 22No. minesweepers were lost during the conflict.

No records have been found of vessels striking magnetic mines and sinking in the vicinity of the Site post-WWII.

Marine mines are not considered to provide a source of UXO hazard to the Site with the possible, albeit very unlikely, exception of buoyant marine mines migrating onto the Site.

5.6 Wrecks Containing UXO

No records have been found indicating that any wrecks are located on the Site.

There are records of more than 50No. wrecks in the mouth of the Humber estuary and approaches. The nearest wrecks possibly containing UXO are detailed below.

9th October 1940

The minesweeper His Majesty's Trawler (HMT) *Sea King* (Wreck 8827) sank, after hitting a mine, approximately 10.6km east-southeast of the Site.

20th March 1941

HMT *Gloaming* (Wreck 8946) sank, following the accidental detonation of an acoustic mine by the minesweeper HMS *DW Fitzgerald*, approximately 5.9km southeast of the Site.

Wrecks are not considered to provide a direct source of UXO hazard to the Site, although they may contribute UXO to the marine environment in the vicinity of the Site. This will mainly comprise SAA and AA shells.

5.7 UXO Migration in the Marine and Estuarine Environment

There are several identified potential sources of UXO hazard in the marine and estuarine environment in the vicinity of the Site.

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

Tidal and Fluvial Currents

The Humber Estuary in the vicinity of the Site has a mean tidal range between approximately 3.2m (neap) and 6.4m (spring). Tidal streams move on both the flood and ebb between approximately 9 knots (neap) and 27 knots (spring). The flow regime fronting Immingham is generally rectilinear, with flows aligned approximately east-southeast on the ebb to west-northwest on the flood. Peak flows above 1.8 m/s are recorded during the ebb tide, with slightly slower flows on the flood phase of the tide.

Wave Action

The wave climate across the Site is generally protected from large waves approaching from the North Sea by a combination of sheltering effects (from Spurn Head, the various banks and channels within the outer parts of the Humber Estuary, and by the local jetties at Immingham).

The wave regime at the Site is dominated by waves approaching from the northwest and the southeast (coincident with the longest fetch lengths at the site). Waves with Hs of above 0.7 m are observed from both of these main approach directions, with a peak Hs value during the deployment of 0.84 m.

The prevailing wave action and tidal streams dominate the nearshore sediment transport and littoral drift in the estuary which may influence UXO migration (see below).

Sediment Pathways

The Humber Estuary is part of the coastal accreting zone cell 2 between Flamborough Head and The Wash. The Humber Estuary has a macro tidal range, fast flows and a high background suspended sediment content. This means the bed of the estuary is very dynamic in its morphology, both in the short term and on longer time scales, particularly in areas where there are no constraints, either geological or man-made.

It is estimated that 2.22 million m^3 of sediment is transported into the estuary from the sea each year, in addition to 0.3 million m^3 brought in by the river.

Over 1,500 tonnes of sediment are carried in with every tide. Approximately 6 million tonnes (dry solid weight) of sediment enter the estuary each year, most of it either as background material from the North Sea or from the rapid erosion of the Holderness coast. Less than 3% of the sediment is from river input.

Qualitative and quantitative source contribution estimates show that 98% of the coarse fraction (up to 250mm diameter) is derived from marine sources.

Much of the marine material returns to the North Sea on the subsequent tide but some remains in the estuary, moving upstream along the shoreline and either accumulating there or entering the deeper channels and being carried back towards the sea.

A review of historical bathymetric charts extending both up and down estuary of the proposed development shows that in the 1930s, the channel up estuary was considerably deeper than present day, with depths of the order of -16 mCD centred about 1 km from the shoreline. The channel has consistently in-filled until about 1990, resulting in a depth of around -7 mCD. During the last 15 years, depths have been relatively stable, although variations between -6 m and 7 mCD have occurred.

Approximately 3 million tonnes of sediment are dredged each year from the docks, port approaches and the main shipping channel. All dredged material is returned to the estuary, generally close to the point from which it was removed. No dredging is recorded as having taken place on the Site.

UXO Migration

Given the tidal currents and sediment movement patterns in the River Humber, it is considered that larger UXO (such as air-dropped bombs), too heavy for the tides and near shore currents to move, are unlikely to be transported onto the Site but rather would be exposed by scour around them and then be left proud of the sediments.

In such cases, the UXO are unlikely to move from source unless disturbed by dredging activities and exposed.

Buoyant and semi-buoyant UXO (as may be the case with some marine mines), smaller, lighter items of UXO (such as small or medium calibre shells), and UXO with neutral buoyancy could move by saltation or roll as bed load particles during ebb or flood tides, or high wave energy storm conditions.

Such conditions may, rarely, provide a pathway for UXO migration onto the Site.

The potential migration of fluvial or marine UXO onto the Site forms part of the low background risk of encountering UXO on any similar site in the UK, as demonstrated by a recent find at Immingham (see Section 6.2).

6 EXPLOSIVE ORDNANCE CLEARANCE ACTIVITIES

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

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

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

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

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

6.1 Abandoned Bombs

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

- Abandoned Bombs

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

6.2 EOC Tasks

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

8th May 2020

1No. a small WWII-era bomb was discovered in the Humber Estuary during dredging off the approaches to Immingham, in the vicinity of the Site. It was destroyed in situ.

7 UXO HAZARD ASSESSMENT

7.1 UXO Hazard Level

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

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

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

Given this, it is considered that the Site has a low UXO hazard level, as shown in Figure 6.

The UXO hazard zone plan of the Site is also given in the accompanying P11863-22-R1-MAP01-A.

It should be noted that the possibility of smaller, lighter items of UXO migrating onto the Site cannot be totally discounted, this forms part of the low background risk of encountering UXO on any similar site in the UK.

Figure 6 UXO hazard zone plan of the Site

Source: OpenStreetMap *Not to Scale*

Legend					
	Very Low		Low		Moderate
	High		Very High		Site boundary

8 UXO RISK ASSESSMENT

8.1 Proposed Works

It is understood that works on the Site are associated with the development of new ammonia import terminal at the Port of Immingham. This includes the construction of a new jetty, along with accompanying pipeline and storage tank areas within existing port infrastructure.

For the purpose of this risk assessment, it is assumed that works on the Site may include dredging, intrusive ground investigations, excavations and piling.

8.2 Risk Assessment Methodology

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

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

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

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

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

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

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

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

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

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

8.3 UXO Risk Level

The UXO risk assessment for proposed works on the Site is given in Table 4.

Table 4 UXO risk assessment for the Site

Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
UXB	Dredging	1	1	1	1	5	5	Low
	Shallow Excavations	1	1	1	1	5	5	Low
	Deep Excavations	1	1	1	1	5	5	Low
	Boreholes/Piling	1	1	1	1	5	5	Low
Other UXO	Dredging	1	1	1	1	5	5	Low
	Shallow Excavations	1	1	1	1	4	4	Low
	Deep Excavations	1	1	1	1	4	4	Low
	Boreholes/Piling	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)								
Shallow Excavations defined as <1.0m below ground level (bgl.)								

9 RISK MITIGATION PLAN

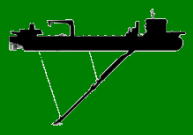
Key findings: No significant sources of UXO hazard have been identified. The potential for UXO to migrate onto the Site due to marine processes cannot be discounted.

Key actions: UXO awareness briefing for staff involved in dredging. EOC Engineer attendance aboard the dredger may be prudent.

9.1 UXO Risk Summary

Table 5 summarises the UXO risk for proposed works on the Site and recommended actions.

Table 5 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Dredging		**UXO awareness briefing** – It is recommended that those involved in dredging operations are provided with a formal UXO awareness briefing so that they take appropriate action in the event of a suspect find. Procedures for an Emergency Response Plan (ERP) in the event of a UXO find should also be established. **EOC Engineer**– If additional comfort is required, an Explosive Ordnance Clearance (EOC) Engineer can be present aboard the dredger during operations.
Excavations		**Proceed with works** – if additional comfort is required to address the residual UXO hazard on onshore areas, a formal UXO awareness briefing can be provided.
Boreholes/Piling		**Proceed with works**

In summary, it is recommended that staff involved in dredging operations are provided with a formal awareness briefing so that they take appropriate action in the event of a suspect find. For additional comfort, an EOC Engineer can be present aboard the dredger and take appropriate action in the event of a suspect item being encountered.

9.2 Risk Mitigation Techniques

9.2.1 UXO Awareness Briefing

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

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

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

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

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

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

9.2.2 Emergency Response Plan

A site-specific emergency response plan (ERP) should be formulated and included as part of the UXO briefing materials.

The ERP should clearly outline the actions to take in the event of a potential UXO find, in agreement with the local port authority and other stakeholders.

The ERP should be discussed with operatives during any UXO awareness briefing to ensure that they understand the appropriate protocol in the event of UXO encounter, which can then be cascaded out to others involved in the scheme.

The information provided should be in line with CIRIA C754 guidance and the 2010 Guidance Note published by the Crown Estate, 'Dealing with munitions in marine sediments' (https://zeticauxo.com/wp-content/uploads/2016/07/Dealing-with-munitions-in-marine-sediments.pdf)

9.2.3 EOC Engineer Attendance

If additional comfort is required, an EOC Engineer can attend site and be present aboard the dredger during operations.

In the event that a suspect item is brought aboard during dredging, the EOC Engineer will be able to quickly identify whether it is UXO-related. This will prevent delays and allow the appropriate measures to be put in place for the disposal of hazardous UXO.

All EOC operatives should have competencies and experience in line with guidance provided by the Institute of Explosives Engineers (https://zeticauxo.com/wp-content/uploads/2016/07/Guidance-Notes-for-Commercial-EOD-in-GB.pdf)

9.3 What Do I Do Next?

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

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

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

APPENDICES

Appendix 1 Anticipated Ordnance Types

The probability of encountering UXO on the Site is considered to be low. As with any similar site in the UK, there is always a background risk of finding ordnance and potential types to be encountered are detailed below. For a more comprehensive set of ordnance data sheets, see http://zeticauxo.com/downloads-and-resources/ordnance-data-sheets/.

Information Data Sheet

Category Small Arms Ammunition
Type Various

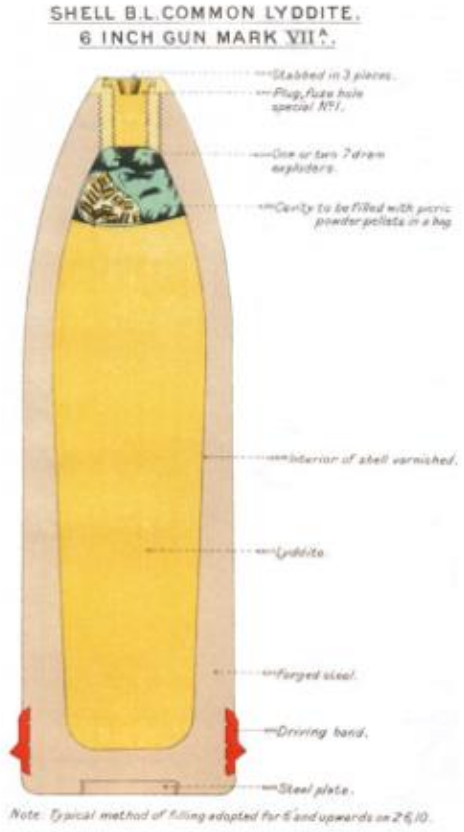
Description: Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance.

SAA is often associated with discarded ammunition boxes around firing practice ranges and training areas and is often found scattered across former military airfields as a result of aircraft crashes and localised disposal.

Information Data Sheet

Category Shell (British)
Type 6-inch Naval Shell



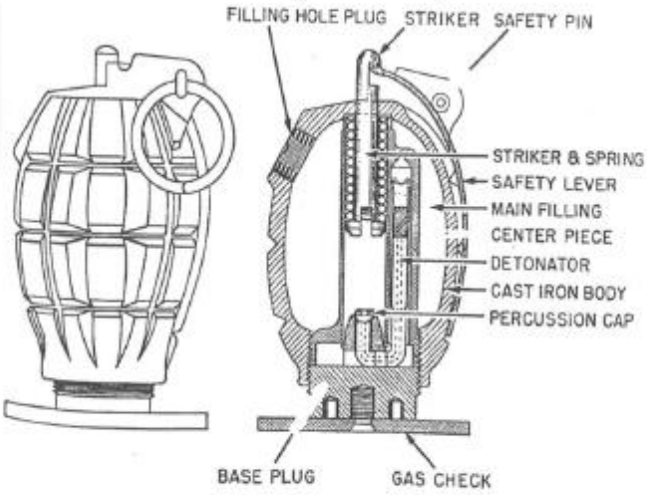
Weight 122lbs (55.59 kg) **Firing Mechanism** Percussion fuse

Description Tapered cylindrical shell.

Function The BL 6-inch gun Mark VII (and the related Mk VIII) was a British naval gun dating from 1899, which was mounted on a heavy travelling carriage in 1915 for British Army service to become one of the main heavy field guns in the First World War, and also served as one of the main coast defence guns throughout the British Empire until the 1950s.

Information Data Sheet

Category Grenades (British)
Type No. 36 Hand Grenade ('Mills Bomb')



Variants	-	**Dimensions**	101.6mm x 61mm (4" x 2.4")
Weight	2 lbs	**Delay**	4 seconds
Filling	Baratol	**Material**	Cast Iron

Description Lemon-shaped, cast-iron body filled with high explosive. Three holes in the body; one in the base for priming, one near the top for filling; one on the top holding striker.

Function Used as a defence against enemy personnel.

Information Data Sheet

Category Grenades (British)
Type No. 76 Self-Igniting Phosphorus Grenade

Variants -

Dimensions 152.4mm x 63.5mm (6" x 2.5")

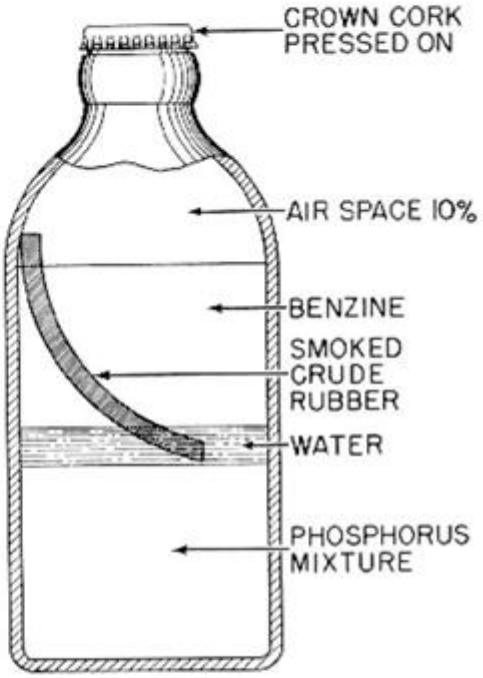
Weight 1lb

Fuze Self-igniting upon breakage

Material Glass

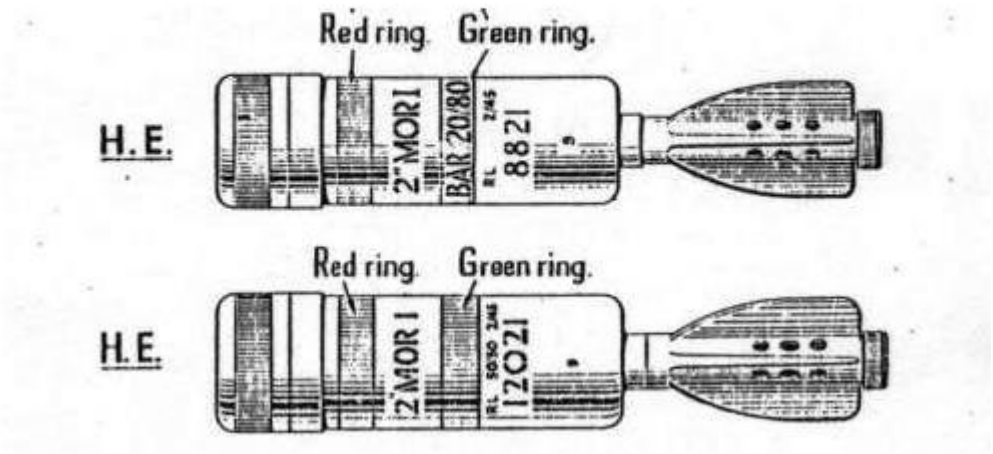
Description Glass bottle filled with white phosphorus, benzene, water and crude rubber.

Function Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.



Information Data Sheet

Category Mortar (British)
Type 2-Inch Mortar Bomb



Variants	14	**Length**	11.4" x 2"
Weight	2.5lbs	**Firing Mechanism**	Trip (small trigger)
Calibre	50.8mm (2.0 inches)	**Rate of Fire**	8 rounds per minute

Description Pear-shaped steel body with 6 or 8 vanes. Originally painted buff yellow or dark grey. Filled with c TNT, granular TNT or powdered Amatol. Also smoke, illumination and practice versions.

Function Small enough to be carried by one man, with a range limited to 500 yards, the 2" mortar was usec an anti-personnel role.

Information Data Sheet

Category Marine Mines

Description

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

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

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

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

Left: Recovered British marine mine. Right: German marine mine at sea during WWII

Hazard

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

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

Information Data Sheet

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

Variants 8

Body Dimensions 762 x 200mm (30" x 7.9")

Weight 55kg (122lbs)

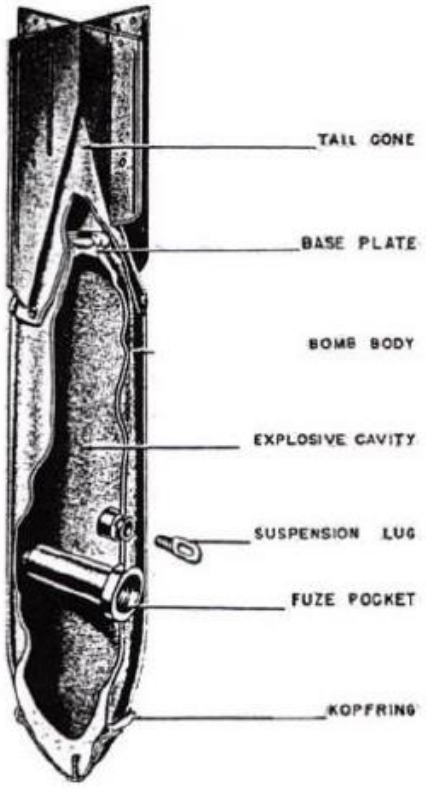
Charge Weight 25kg (54lbs)

Fuze Single electric impact fuze. Some have short time delay

Composition Sheet steel

Description Thick nose welded to a steel body. Nose may be attached to Kopfring (a triangular section steel ring) or spike. Suspension bolt in eye/body and sheet metal tail attached to body with rivets/screws. Originally painted green-grey with a yellow stripe on the tail. Cast TNT, Amatol or Trialen filling.

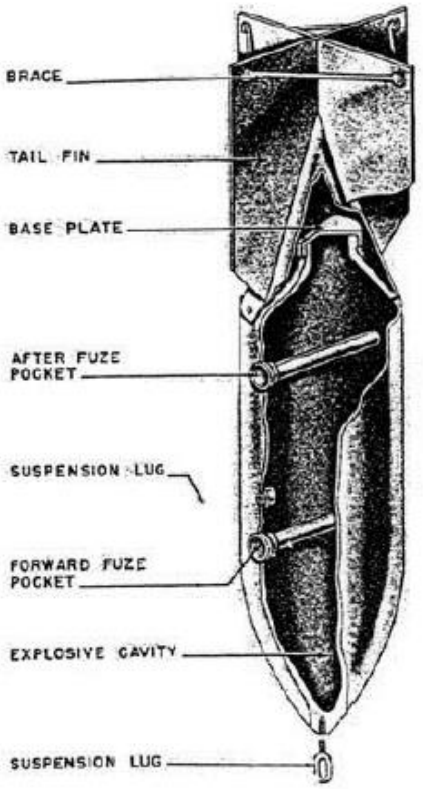
Function Designed to maximise shock waves through air, water and earth and for general demolition. Used against easily damageable targets, including roads, aircraft hangars, rolling stock and small buildings. Spike bombs/ 'Stabo' (SC 50 with spikes attached to nose) were used against rail lines and country roads, with Kopfring used against naval targets.



Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 250kg

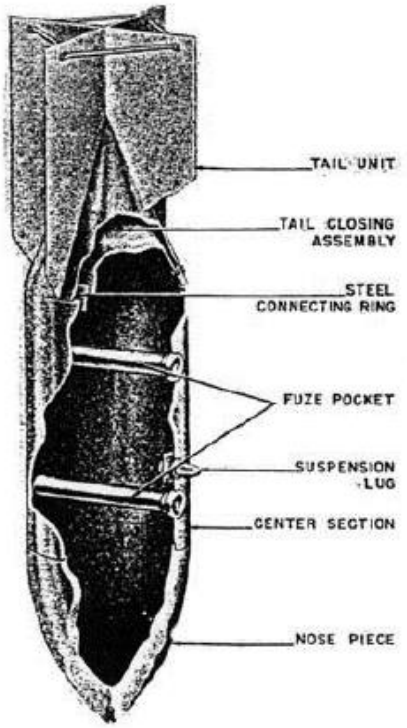
Variants	8
Body Dimensions	1194mm x 368mm (47" x 14.5")
Weight	249-264 kg (548-582lbs)
Charge Weight	130-145 kg (287-320lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze
Composition	Sheet steel with stays
Description	Thick nose welded to steel body. Nose may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



Information Data Sheet

Category Bomb
Type Sprengbombe-Cylindrisch (SC) 500kg

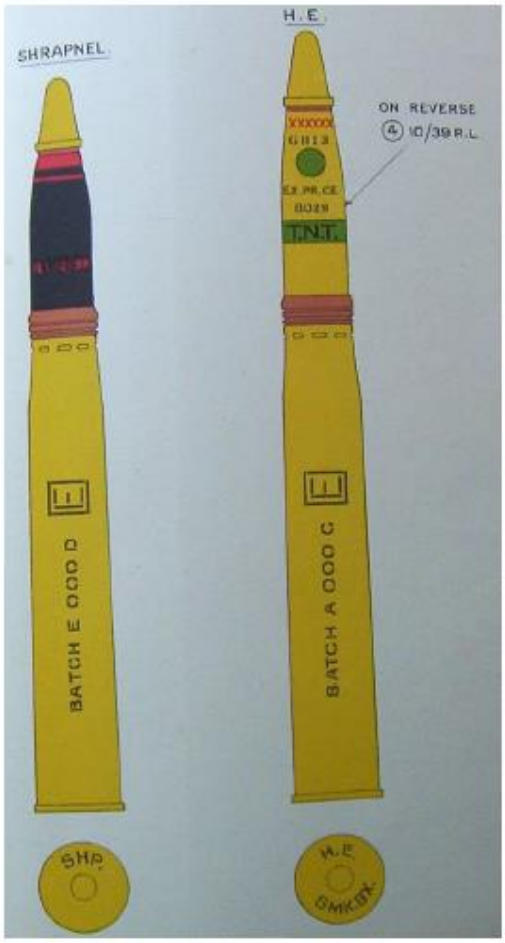
Variants	-
Body Dimensions	1414–1486mm x 470mm (55.7-58.5" x 18.5")
Weight	500kg (1,100lbs)
Charge Weight	220kg (484lbs)
Fuze	Electric impact fuze/electric clockwork time fuse & electric anti-disturbance fuze.
Composition	Sheet steel with stays or drum
Description	Thick nose welded to steel body. Nose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



Information Data Sheet

Category Projectile
Type 3.7" Anti-Aircraft Shell

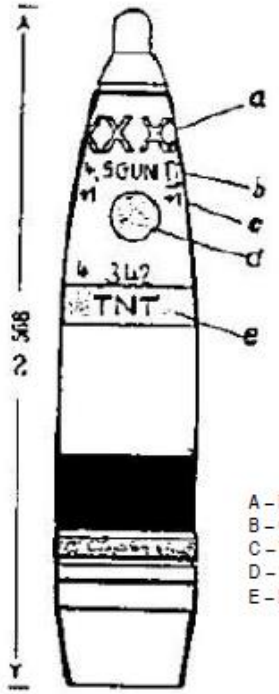
Variants	6
Body Dimensions	94mm x 360mm (3.7 x 14.7")
Weight	12.7kg (28lb)
Fuze	Mechanical time fuze
Composition	Cast steel
Description	Brass cartridge case. Square-based shell with tapered nose, filled with Amatol, TNT or RDX/TNT. MK6 had forward centring bands and a wider driving band.
Function	Used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



Information Data Sheet

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

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



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

Appendix 2 Sources of UXO Hazard

The sections below provide background information on the potential sources of UXO hazard (albeit low) affecting the Site. For a more comprehensive set of UXO information sheets, see http://zeticauxo.com/downloads-and-resources/uxo-information-sheets/.

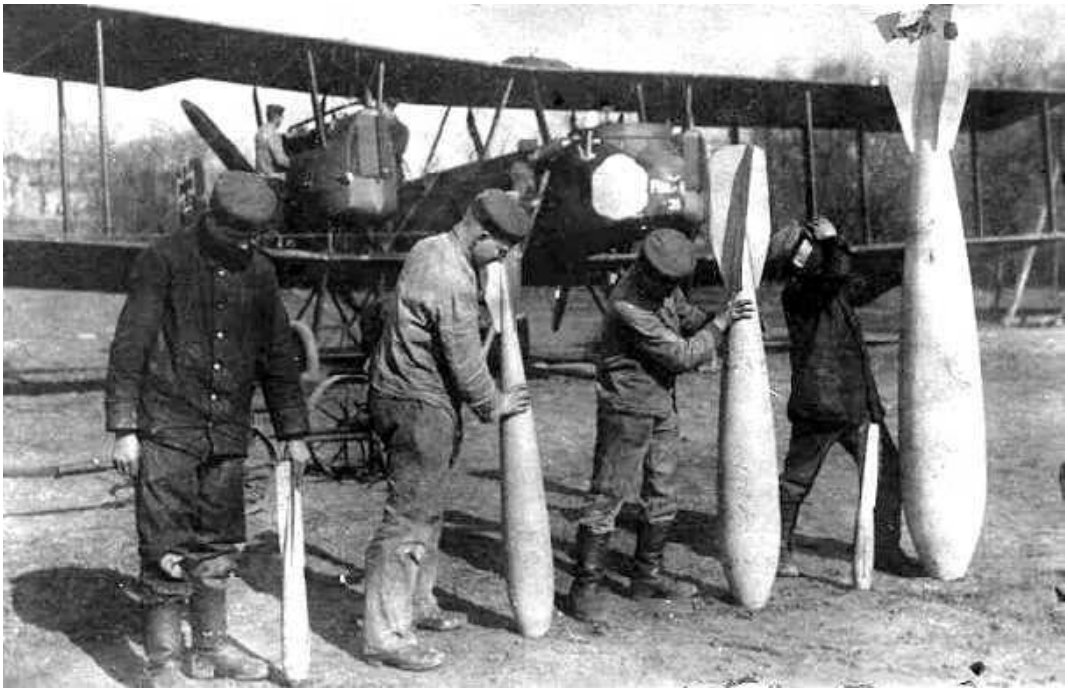
Appendix 2.1 WWI Bombing

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

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

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

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



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

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

Appendix 2.2 WWII Bombing

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

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

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

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

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

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

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

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

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

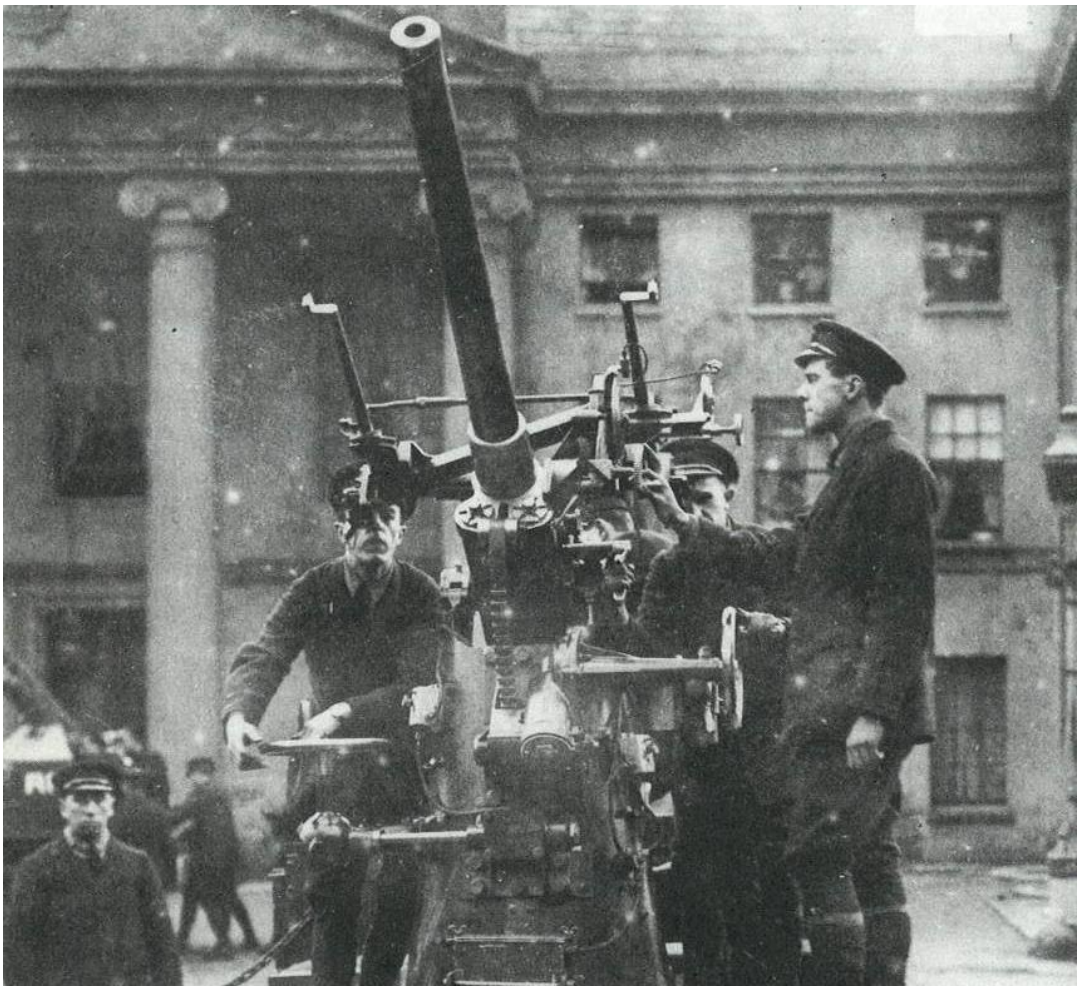
The potential for a UXB hazard to exist on a site depends on a variety of factors. Were there strategic targets in the surrounding area? Was the site bombed? Could a UXB impact have been missed? Even in rural areas, the potential for UXB cannot be totally discounted and therefore it is essential that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

Appendix 2.3 Anti-Aircraft Guns

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

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

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



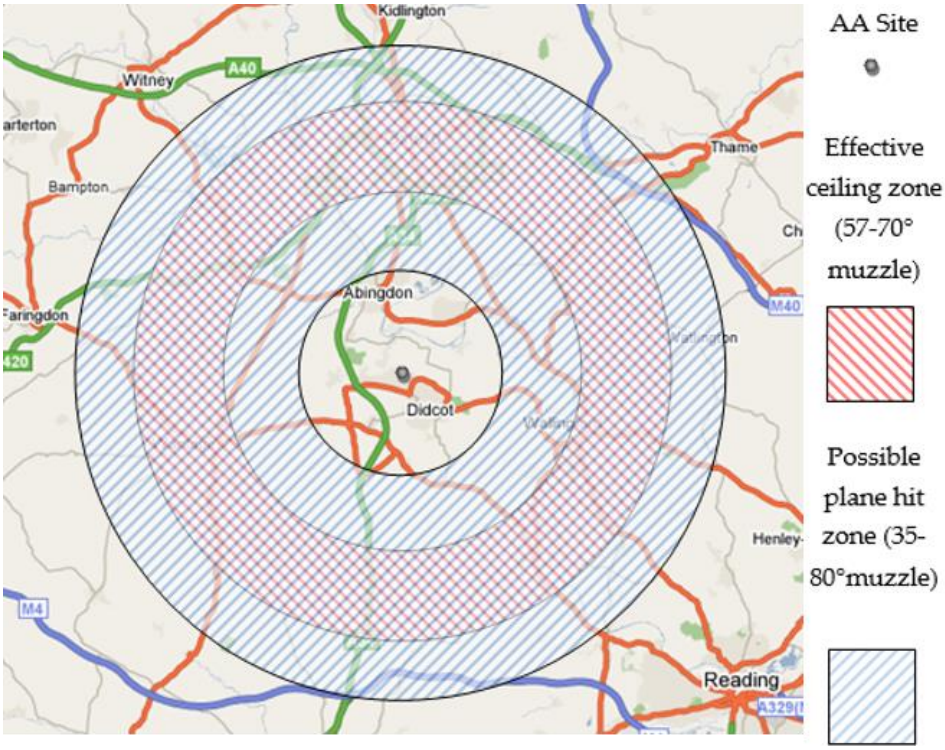
AA gun batteries were used extensively during WWII to counter the threat posed by enemy aircraft. In many instances, AA shells caused damage to Allied territory and in some areas caused significant numbers of civilian fatalities.

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

3No. types of AA batteries existed:

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

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



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

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

Appendix 2.4 Barrage Balloons

Balloon barrages were flown in many British towns and cities to protect against air raids and defend key targets such as industrial areas, harbours and ports. Their presence deterred low flying aircraft, making it more difficult for bombs to reach their intended targets; enemy raiders were forced to fly higher and thus bombed targets with far less accuracy. The wires holding the balloons up also served as a form of defence, cutting into the planes.

By the middle of 1940, there were 1,400 balloons, a third of these over the London area. Many of the barrage balloons contributed to 'Operation Pegasus', the Free Barrage Balloon (FBB) operation, in which untethered balloons armed with explosive charges and aerial mines were allowed to drift towards enemy aircraft. Although their use increased as WWII progressed, the success of the balloons was limited as they also posed a significant threat to British aircraft.

Barrage balloon positions were associated with small caches of munitions, often comprising small arms and minor explosive charges. Most of these were removed at the end of WWII and, in general, these anti-aircraft defences are not considered to provide a significant source of UXO hazard.

Some barrage balloon positions were also targeted by Luftwaffe bombers and therefore there may be a heightened UXB risk in these areas.

Appendix 2.5 UXO in the Marine Environment

Both wartime and peace time military and naval activities provide numerous sources of UXO within the marine environment. In addition to coastal and offshore artillery and bombing ranges, the principal sources of marine UXO hazards are from ordnance disposal at sea; aerial or ship laid mines, depth charges and torpedoes; projectiles, shells and bombs left in battle conflict zones; mines laid as beach defences; crashed aircraft and wrecks containing ordnance.

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

UXO is most likely to be concentrated on and immediately around the principal sources of the UXO hazard but, given sufficiently high energy events over long time periods, migration from source can never be entirely discounted.

Appendix 2.6 Marine Mines and Minefields

During WWI, approximately 128,000No. mines were laid in the sea around the coast of the UK.

At the beginning of WWII the Admiralty ordered the laying of further extensive minefields around the coast of England. This included both defensive mines on beaches in order to prevent enemy landings, as well as approximately 100,000No. marine mines laid at sea to destroy enemy ships.

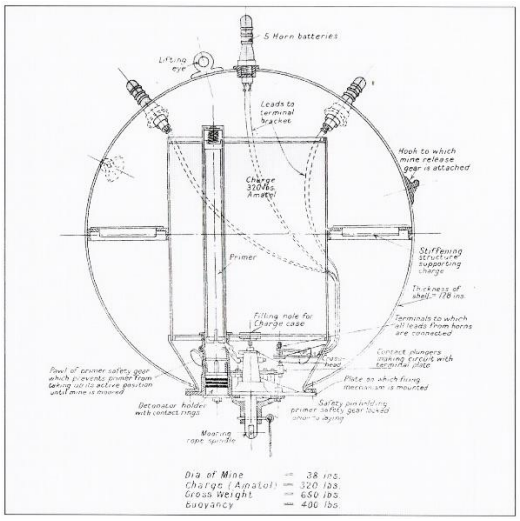
Buoyant mines, designed to drift free, float or sit just below the surface, were the most commonly deployed marine mines. They were typically moored, or tethered to the seabed with an anchor or wire.

After deployment, cables or anchor systems designed to keep the mine at predetermined depths often failed, allowing previously moored mines to be moved from their original locations by currents. They could also be moved by later fishing activity such as trawling.

Generally spherical in shape, the mines were comprised of 2No. hemispheres connected with a cylindrical mid-section.

Marine mines typically carried 100 to 500lbs (50 to 250kg) of explosive. They were detonated by contact (being struck) or by influence (a vessel interfering with the mine's electromagnetic field).

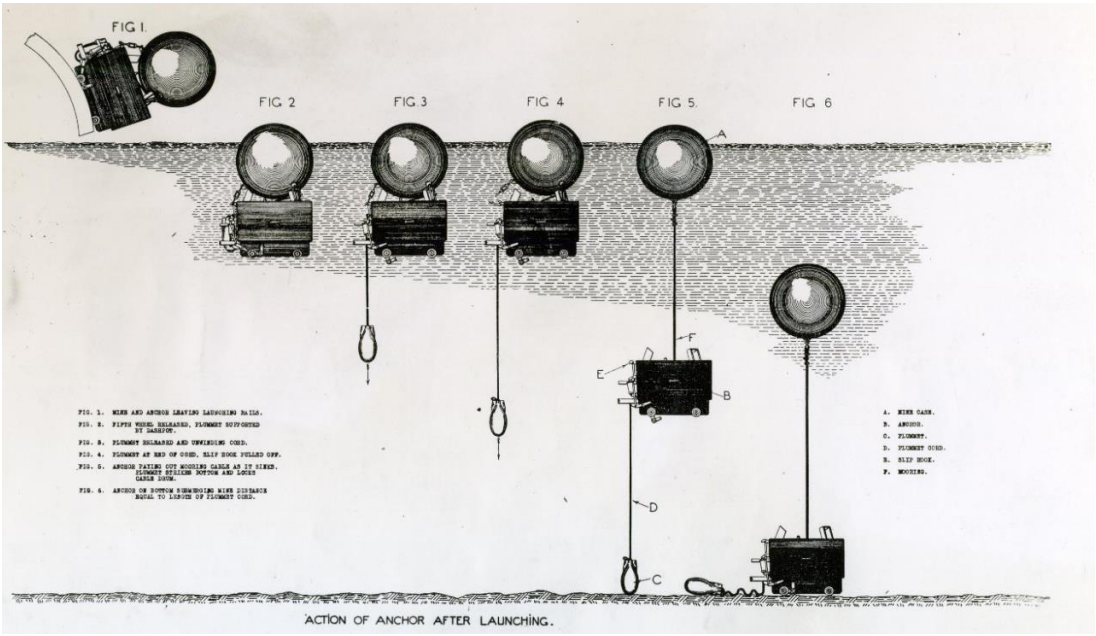
Marine mines deployed during WWI were mostly activated by contact mechanisms, those during WWII were activated by either contact or influence mechanisms, or a combination of both.



German ground mines (Luftmine) were air-deployed naval mines which were also modified for deployment from submarines and surface craft. Although primarily designed to lie on the seabed, many were also moored or buoyant. Designed as an anti-shipping weapon, the WWII Luftmine was also often used on land based targets.

Luftmines typically comprised a cylindrical body with a hemispherical nose and tapered tail, with charges weighing between 675lbs and 1,500lbs (305 to 680kg).

Some German marine mines were composed of aluminium or manganese steel depending on the variant, whereas British mines were typically made of steel



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

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

Air-dropped German mines that did not detonate may remain unexploded in coastal areas around the UK, in addition to in lakes and reservoirs, and rivers.

Appendix 2.7 Munitions Disposal at Sea

Both chemical and conventional munitions have been extensively dumped at sea since WWI.

In a few cases, the location and types of munitions are well known. In many cases the locations and types are not well known due to insufficient record keeping, dumping of material intentionally or unintentionally outside agreed official dumping areas and, to some extent, the movement of dumped munitions to areas outside the disposal points.

A comprehensive list of dumped conventional or chemical weapons material does not exist, and the composition of munitions in many dumping incidents is unknown.

The materials that have been dumped around the UK are mostly captured German, British, and American munitions, the vast majority being conventional weapons which were excess to requirements at the end of WWI or WWII.

During WWII, many munitions were dumped indiscriminately before vessels returned to shore. Between 1944 and the 1970s, large scale disposal of excess munitions in the marine environment took place in both specified and unspecified locations.

For example, between July and October 1945, 14,000 tons of 5” artillery shells, loaded with phosgene, are recorded as being dumped in the Beaufort's Dyke trench off the coast of Scotland. Between 1945 and 1948, 135,000 tons of both conventional and chemical

munitions were dumped there, and between 1949 and the late 1950s, approximately 20,000 tons/year were disposed of in the trench.

During ‘Operation Sandcastle’ (1954-1956) merchant ships with cargoes of Tabun were recorded as being scuttled in Beaufort's Dyke and the Irish Sea. By the early 1970s, approximately 3,000 tons/year of, mostly defuzed, conventional munitions were being disposed of. The last recorded dump at Beaufort's Dyke took place in 1976, when crews performed an emergency dump of a small number of 40mm shells.

The Scottish MoD estimates that Beaufort's Dyke currently contains nearly 2 million tons of conventional munitions, 120,000 tons of mustard and phosgene gas, 25,000 tons of nerve gas, 330 tons of arsenic compounds and 1,890 tons of waste gases.

Some evidence indicates that following corrosion certain types of munitions are able to float and that these can wash ashore if disturbed. There are records indicating that, following pipe laying disturbance in the 1990s, explosives and case material from Beaufort’s Dyke were encountered on beaches. Spontaneous explosions have also been recorded in the region of the Beaufort’s Dyke dumping ground by BGS seismic equipment.

The potential UXO hazard from offshore munitions disposal sites is elevated for deep sea fishermen or those involved with offshore construction projects such as pipe laying, dredging and wind farms.

Appendix 3 Recent UXO Finds

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix 4 Glossary and Definitions

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

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

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

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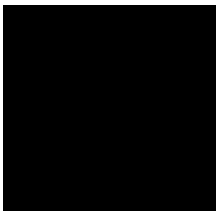


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