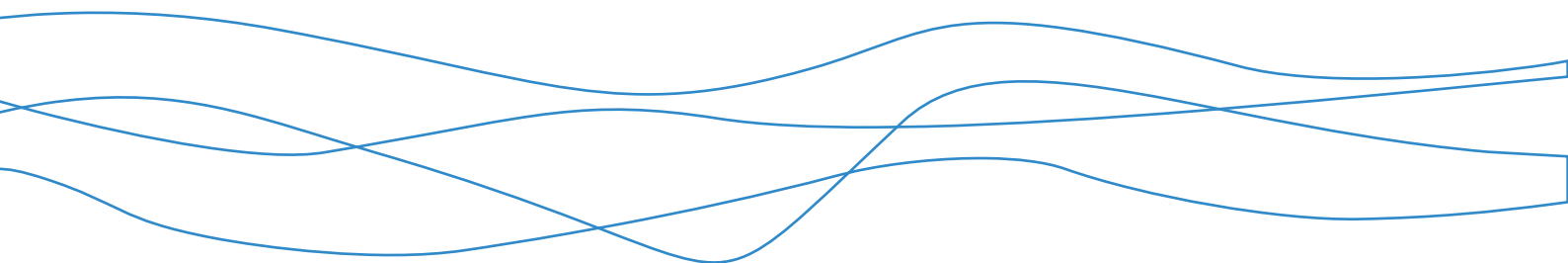




Bowdun Offshore Wind Farm, Offshore EIA Report

Volume 3, Technical Appendix 19.2: Unexploded
Ordnance Technical Report

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Glossary

Defined term	Definition
Additional Mitigation	Also referred to as secondary mitigation which is defined by The Institute of Sustainability and Environmental Professionals (ISEP) (formerly Institute of Environmental Management and Assessment (IEMA)) as: Actions that will require further activity in order to achieve the anticipated outcome. These may be imposed as part of the planning consent, or through inclusion in the EIA Report (sic).
Array Area	The Array Area is the area in which the Offshore Generation Assets will be located.
Environmental Impact Assessment (EIA)	Process for the assessment of likely significant environmental effects of a project on the physical, biological and human environment during construction, Operation and Maintenance (O&M) and decommissioning.
Export Cable Corridor	The area seaward of MHWS which connects the Array Area with the Landfall within which the Offshore Export Cables will be installed.
Fuse	A designed and manufactured mechanism to activate munitions. It can be designed for use by electrical, chemical or mechanical systems, by push, pull, pressure, release and time activation, singly or in combination. Usually consists of an igniter and detonator.
High Explosive (HE)	An explosive that normally detonates rather than burns; that is, the rate of detonation exceeds the velocity of sound.
High Voltage Alternating Current (HVAC)	A system of power transmission and distribution that utilises alternating current at voltages typically exceeding 1000 volts, as defined by the International Electrotechnical Commission (2015). HVAC systems are designed to efficiently deliver electricity over long distances with minimal losses, leveraging transformers to modify voltage levels.
Impact	A change caused by an action that occurs during a project's lifetime.
Inter-Array Cables (IAC)	Cables which link the Wind Turbines to each other and with the OSPs.
Interconnector Cables	Cables which will connect individual OSPs to each other to provide redundancy against cable failure elsewhere.
Landfall	The area in which the Offshore Export Cables make Landfall and is also the transitional area between the Offshore Transmission Assets and the Onshore Transmission Assets. Located in the Intertidal Area at Benholm.
Mitigation	Measures to avoid, prevent, reduce or control effects on the environment. See also definitions for Embedded Mitigation and Additional Mitigation.
Offshore Export Cables	Subsea cables used to transmit electricity generated offshore by the Wind Turbines from the OSPs to shore. The Transition Joint Bay (TJB) is the location where the Offshore Export Cables terminate, and the onshore cabling begins.
Offshore Infrastructure	All of the Offshore Infrastructure associated with the Proposed Development that is located seaward of MHWS, comprising the Offshore Generation Assets and the Offshore Transmission Assets.

Defined term	Definition
Offshore Substation Platform(s) (OSPs)	OSPs comprise the support structure, topside and electrical components used for collecting and/or converting electricity generated by the Wind Turbines for transmission by the Offshore Export Cables.
Operation and Maintenance (O&M)	The phase of the Proposed Development following completion of construction. This phase of development includes routine inspections, repairs and replacement of infrastructure and equipment (including Interconnector Cables and IACs), Scour Protection replenishment or replacement, major component replacement, painting and/or other coating works, removal of marine growth, and replacement of access ladders.
Pathway	Describes the means or route by which a receptor (such as the seabed) can be affected by an identified impact source (such as Wind Turbine foundations).
Project (the)	An overarching term for the Bowdun Offshore Wind Farm (Bowdun OWF) comprising the offshore and onshore infrastructure required to generate and transmit electricity from the Array Area to the onshore GCP. The Project includes the Offshore Generation Assets, the Offshore Transmission Assets and the Onshore Transmission Assets.
Proposed Development	Term used to define the Offshore Infrastructure associated with the Project seaward of MHWS for which consent is being sought. Further details of the parameters are included in Volume 1, Chapter 3: Project Description.
Scour Protection	Protective materials installed to avoid sediment being eroded away from the base of the foundations and/or buried subsea cable due to the flow of water.
Site Boundary	The boundary within which all elements of the Proposed Development will be located. The Site Boundary comprises the Array Area and Export Cable Corridor which ends at MHWS.
Study Area	For each environmental topic, the baseline environment will be characterised, and the potential environmental impacts will be described within a topic-specific study area. Specific study areas are defined for each topic and are based on the maximum spatial extent across which potential impacts of the Project may be experienced by the relevant receptors (i.e. Zone of Influence).
Thistle Wind Partners (TWP)	Company established for the development of the Project.
Unexploded Bomb (UXB)	The term UXB refers to any WWII aerial-delivered unexploded bomb, torpedo, projectile or mine consisting of a complete ferrous casing (without tailfins) weighing 50 kg or greater.
Unexploded Ordnance (UXO)	Explosive ordnance that has been primed, fused, armed or otherwise prepared for action, and which has been fired, dropped, launched, projected or placed in such a manner as to constitute a threat to the safety and/or security of people, animals, property or material and remains unexploded either by malfunction or design or for any other reason.
Wind Turbines	Structures comprising of a tubular tower, rotor blades, and a nacelle which houses the Wind Turbine generator.

Acronyms

Acronym	Definition
AAA	Anti-Aircraft Artillery
ALARP	As Low as Reasonably Practicable
COSHH	Control of Substances Hazardous to Health
CPT	Cone Penetration Tests
EIA	Environmental Impact Assessment
EOD	Explosive Ordnance Disposal
HDD	Horizontal Directional Drilling
HD	High Definition
HE	High Explosive
HIRA	Hazard Identification and Risk Assessments
IAC	Inter-Array Cable
ID&C	Identification and Clearance
INS	Inertial Navigation System
MAG	Magnetometer
MBES	Multibeam Echosounder
MFE	Mass Flow Excavation
O&M	Operations and Maintenance
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PLGR	Pre-Lay Grapple Run
POA	Plan Option Area
PPE	Personal Protective Equipment
pUXO	potential Unexploded Ordnance
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
ROV	Remotely Operated Vehicle
SCUBA	Self-Contained Underwater Breathing Apparatus
SMP	Sectoral Marine Plan
SSS	Sidescan Sonar
USBL	Ultra-Short Base Line
UXO	Unexploded Ordnance

Table of Units

Units	Definition
%	Percent
Cm	Centimetre
Kg	Kilogram
kHz	Kilohertz
Km	Kilometre
km ²	Square kilometre
M	Metre
Mm	Millimetre
m/s	Metre per second
W	Watts

1 Introduction

- 1.1.1 This Unexploded Ordnance (UXO) Technical Report presents a Desktop Study and Risk Assessment for potential UXO contamination for the offshore elements of the Bowdun Offshore Wind Farm (OWF) Project (hereafter referred to as the Proposed Development). The Proposed Development covers the Option Lease Area (OLA) comprises of the Array Area, which is located in the E3 Plan Option Area (POA) detailed in the Scottish Sectoral Marine Plan (SMP) (Scottish Government, 2020), and the Export Cable Corridor. The Array Area is located 38 km from the Aberdeenshire coast at its closest point, covering an area of 187 km² (Figure 2.1). The Proposed Development will comprise of Wind Turbines (fixed foundations), Inter-Array Cables (IACs), Offshore Substation Platforms (OSPs), Interconnector Cables, Offshore Export Cables and any necessary scour/cable protection. The Export Cable Corridor will include a maximum of three High Voltage Alternating Current (HVAC) Offshore Export Cables, each with a length of up to 70 km and will make Landfall at Benholm, Aberdeenshire.
- 1.1.2 This report provides an overview and easy access to future operations, in respect of UXO risk handling for all potential upcoming investigation and installation activities. It also provides a UXO risk mitigation strategy for the future maintenance of the Proposed Development.
- 1.1.3 The principal aim of this report is to provide the Proposed Development with an appropriate and pragmatic assessment of the risks posed by UXO in order to identify a suitable methodology for the mitigation of any identified risks to an acceptable level in accordance with the 'As Low As Reasonably Practicable' ('ALARP') Principle.
- 1.1.4 The Proposed Development covers the Option Lease Area that is located in the E3 Plan Option Area (POA), detailed in the Sectoral Marine Plan (SMP) for Offshore Wind Energy (Scottish Government, 2020), and the Offshore Export Cable Corridor. The Array Area will comprise the Wind Turbines, Inter-Array Cables (IACs), Offshore Substation Platforms (OSPs), Interconnector Cables and any necessary scour/cable protection.

1.2 Aims

- 1.2.1 The principal aim of this report is to provide the Proposed Development with an appropriate and pragmatic assessment of the risks posed by UXO in order to identify a suitable methodology for the mitigation of any identified risks to an acceptable level in accordance with the 'ALARP' Principle.
- 1.2.2 The 'ALARP' Principle is clearly defined in Figure 1.1.

1.2.3 The following facets are covered within this report:

- **UXO Risk Analysis:** Assessment of the specific military, former military and UXO related activities that have taken place within the vicinity of the project area. Additionally, to review any previous UXO clearance/mitigation operations that have already taken place within the Development Area. Then, to assess the risks which the identified UXO types present to the installation/survey activities.
- **Recommendations:** Based on the outcome of the assessment, appropriate mitigation measures have been recommended to allow works to proceed safely and with minimal disruption. The recommendations will be designed to reduce the risk on site to 'ALARP'.

1.2.4 This Technical Report focuses on historical activities that occurred within the UXO Study Area (Site Boundary and a 5 km buffer surrounding the Site Boundary), shown in Figure 2.1, with respect to the likelihood of encountering potential UXO and any associated risk with the Proposed Development.

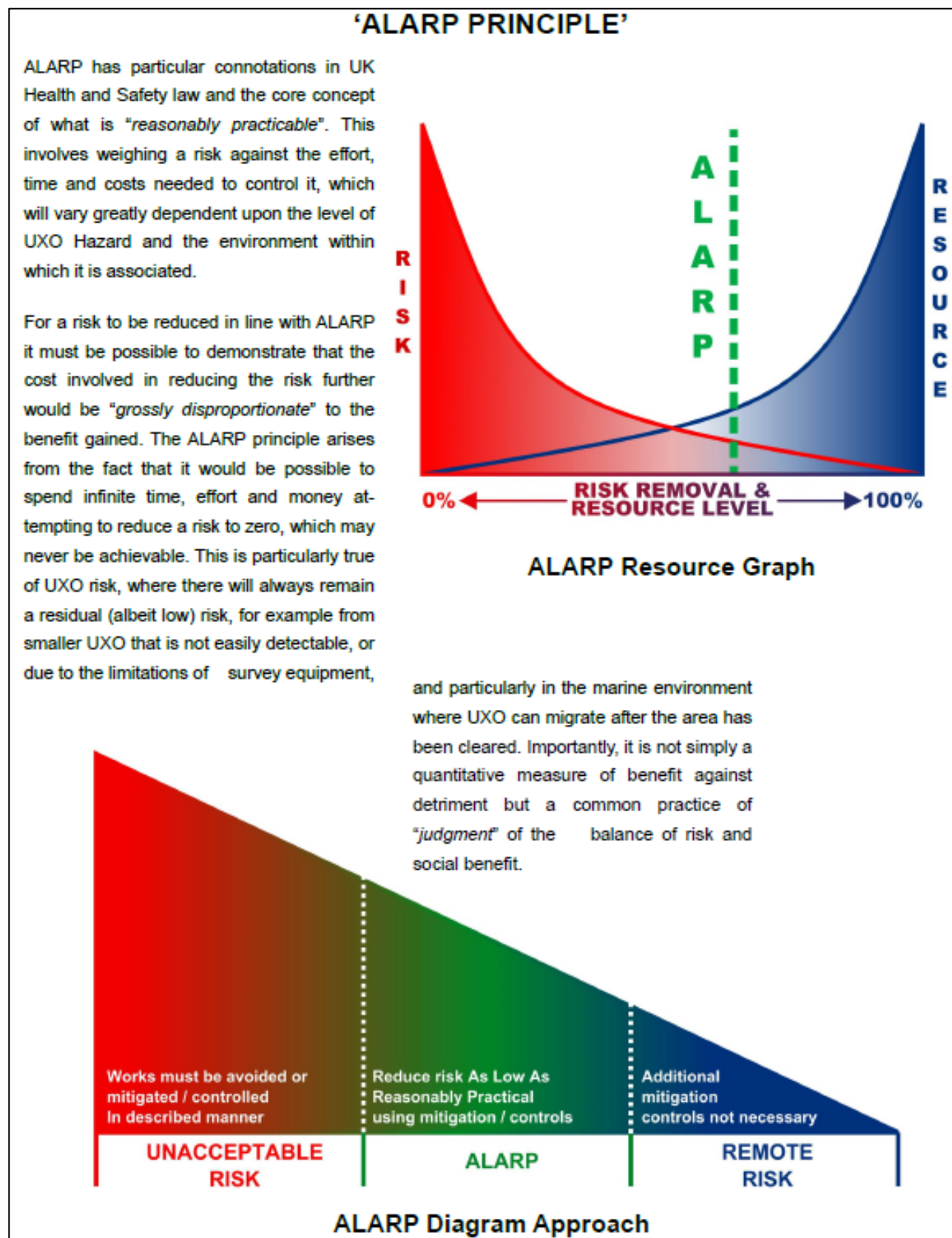


Figure 1.1: ALARP Principle

1.3 Reporting Conditions

- 1.3.1 This study consists of a desk-based collation and review of available documentation and records relating to the possibility of UXO being present within the Site Boundary, in addition to site-specific geophysical survey data. Certain information obtained for the purposes of this study are either classified, restricted material or considered to be confidential. Therefore, summaries of such information have been provided.
- 1.3.2 It must be emphasised that this desk study is only able to identify the potential for UXO to be present. Whilst a geophysical survey of the site has been conducted, further geophysical surveys and target investigation may be necessary to provide confirmation of the presence of UXO and the actual risks involved.

1.4 Data Sources

- 1.4.1 The main sources of information consulted for this report were obtained from within the public domain. Additional sources reviewed are below:
- Tetra Tech RPS archives;
 - military archives;
 - national archives;
 - historic maps, aerial photographs, and records;
 - internet research; and
 - geophysical datasets.

1.5 Legislation

- 1.5.1 Whilst undertaking this desk study the requirements of a number of legislations have been considered, as presented following:
- Manufacture and Storage of Explosives Act 2005;
 - Health & Safety at Work etc Act 1974;
 - Construction (Design & Management) Regulations 2015;
 - Control of Substances Hazardous to Health (COSHH) Regulations 2002; and
 - Personal Protective Equipment at Work Regulations 1992.
- 1.5.2 The Manufacture and Storage of Explosives Act 2005 does not specifically relate to UXO, but rather to the safety procedures and requirements associated with the storage and manufacturing of items containing explosive compounds. Even though this legislation is not directly applicable to site works where UXO may be encountered, there are several pertinent points which may be borne in mind when undertaking works on sites which pose a risk from encountering UXO, for example:

- Disposal of explosives and decontamination of explosive-contaminated items:
 - *“any person who disposes of explosives shall ensure, as far as is reasonably practicable, that they are disposed of safely;*
 - *any person who decontaminates explosive-contaminated items shall ensure, as far as is reasonably practicable, that they are decontaminated safely; and*
 - *no person shall store explosives unless he holds a licence for their storage and complies with the conditions of that licence.”*

1.5.3 These points reinforce that when a significant risk from UXO is identified, it is essential for proper procedures to be put in place and in higher risk scenarios for trained explosives safety personnel to be present on site to mitigate the risks and be on hand to handle the situation in the event of a suspicious item/UXO discovery.

1.5.4 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), place a legal duty on:

- employers;
- self-employed people; and
- people in control of premises.

1.5.5 To report work related deaths, major injuries or over-three-day injuries, work related diseases, and dangerous occurrences (near miss accidents).

1.5.6 These regulations do not directly apply to UXO, but under the RIDDOR legislation it is stated that as an employer, a person who is self-employed, or someone in control of work premises you must report *“dangerous occurrences - where something happens that does not result in an injury but could have done”*. As such, where a site has been shown to present a risk from UXO this legislation should be borne in mind if an eventuality occurs where an item of UXO is uncovered.

1.5.7 Although the Health & Safety at Work etc. Act 1974 and the Construction (Design & Management) Regulations 2007 do not specifically require a search for UXO, there is an obligation on those responsible for intrusive works to ensure that comprehensive assessment and risk mitigation measures are taken with regard to all underground hazards on site.

1.5.8 The Health & Safety at Work etc Act 1974 - Section 3, states:

- *“It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.*

- *It shall be the duty of every self-employed person to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that he and other persons (not being his employees) who may be affected thereby are not thereby exposed to risks to their health or safety.*
- *In such cases as may be prescribed, it shall be the duty of every employer and every self-employed person, in the prescribed circumstances and in the prescribed manner, to give to persons (not being his employees) who may be affected by the way in which he conducts his undertaking the prescribed information about such aspects of the way in which he conducts his undertaking as might affect their health or safety."*

1.5.9 Construction (Design & Management) Regulations 2007 - Regulation 10 states:

- *"(2) The pre-construction information shall consist of all the information in the client's possession (or which is reasonably obtainable), including –*
- *(a) Any information about or affecting the site or the construction works."*

1.5.10 In addition to the above, the importance of adhering to safe systems of work should also be borne in mind, and explosives and their residues may have an implication concerning Personal Protective Equipment (PPE) requirements and COSHH.

2 UXO Study Area

2.1.1 The UXO Study Area is the Site Boundary and a 5 km buffer. This is shown in Figure 2.1.

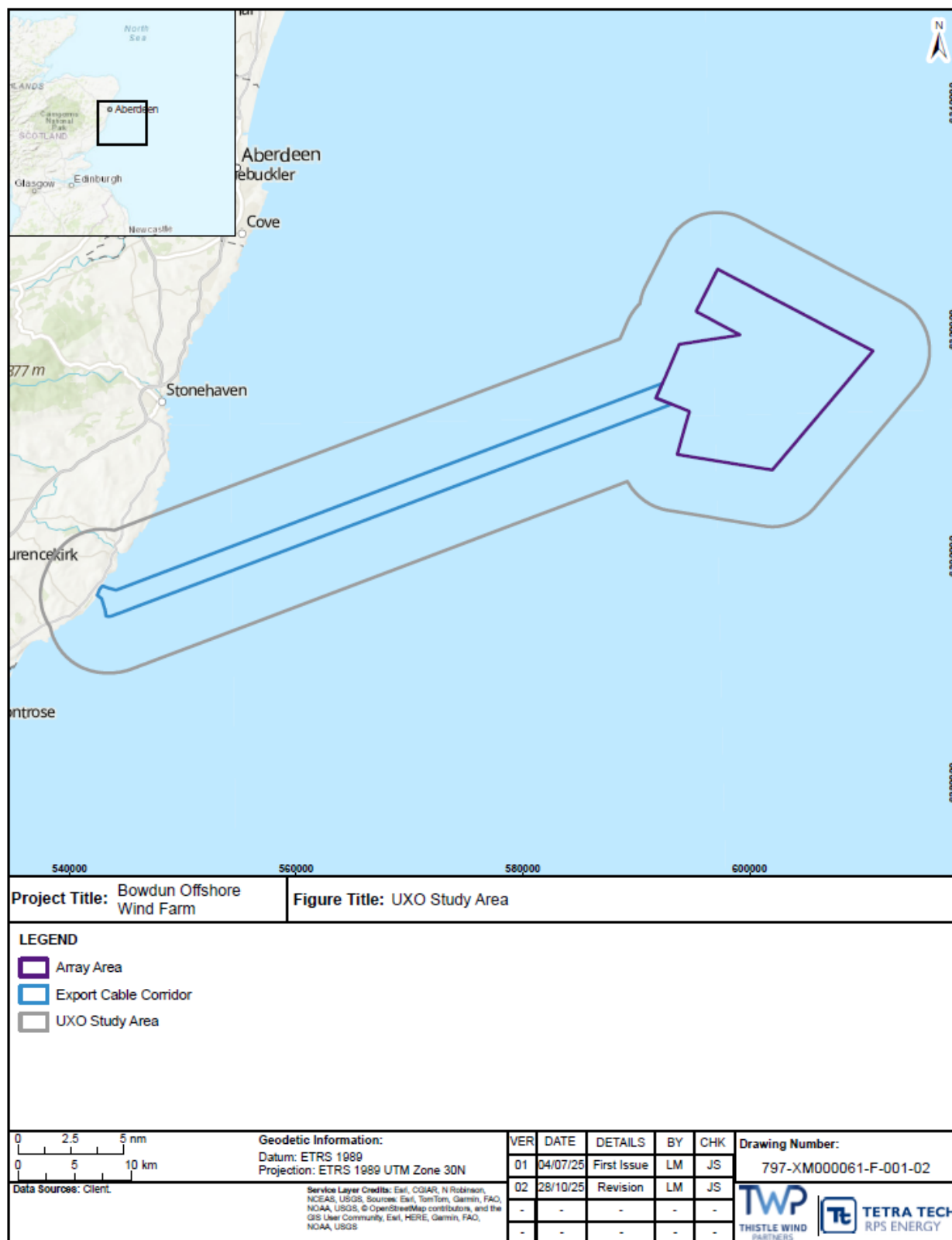


Figure 2.1: UXO Study Area

2.2 Proposed Scheme of Work

2.2.1 As outlined in the Project Description (Volume 1, Chapter 3: Project Description), the following activities may take place during the construction phase:

- cable lay;
- ploughing;
- tracked vehicle jetting;
- chain cutter;
- dredging;
- backhoe dredger;
- Mass Flow Excavator (MFE);
- Horizontal Directional Drilling (HDD);
- anchoring;
- jack-up operations;
- piled foundations;
- suction bucket foundations;
- rock placement;
- mattress installation;
- peel grab operations;
- Pre-Lay Grapnel Run (PLGR);
- borehole/vibrocore;
- Cone Penetration Test (CPT); and
- grab sampling.

Note: It is not expected that all activities listed above will take place during construction.

3 Unexploded Ordnance Risk Analysis

3.1.1 The potential sources of UXO on site are outlined in this section. Identified UXO features are shown visually in Figure 3.1 and Figure 3.2.

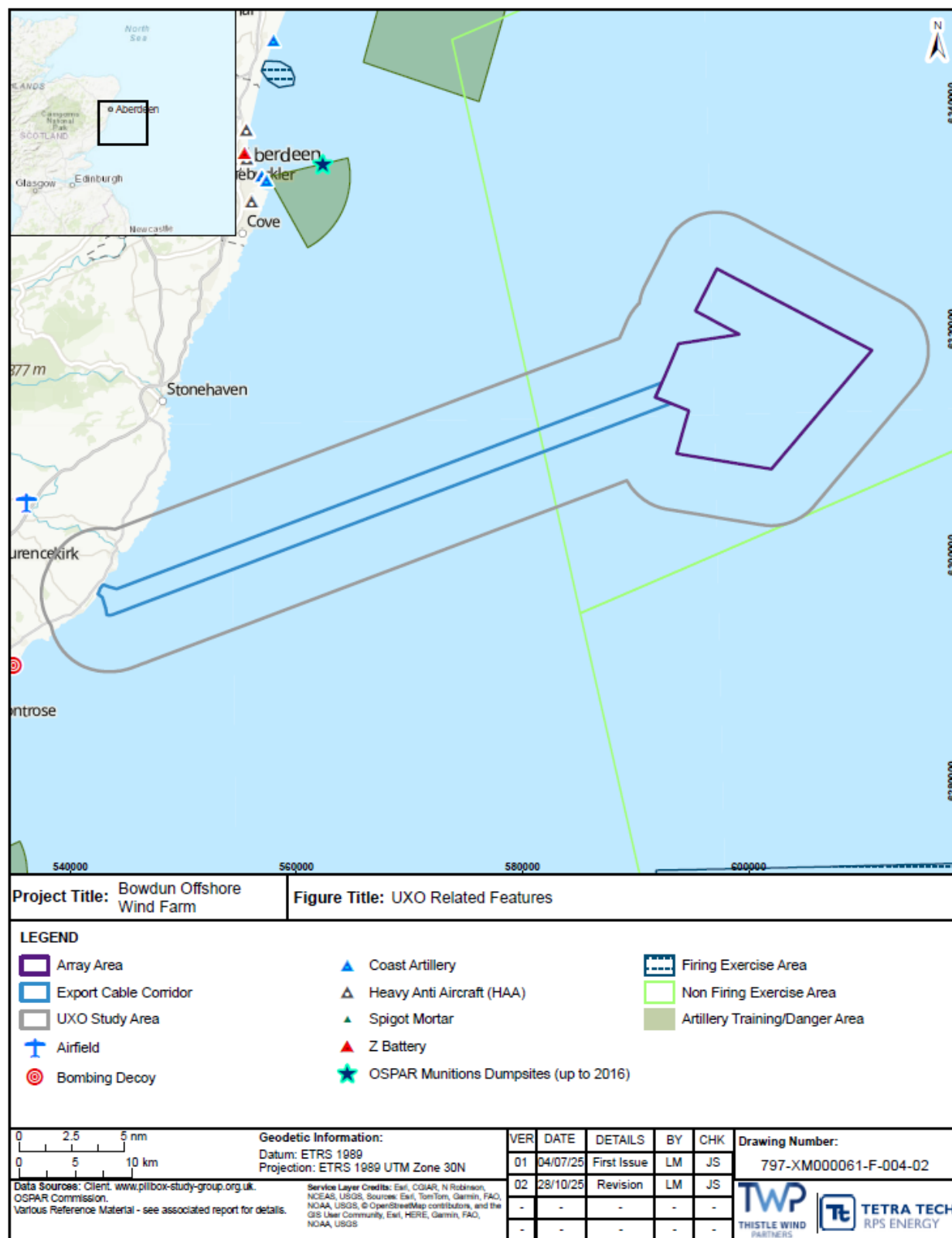


Figure 3.1: UXO Related Features

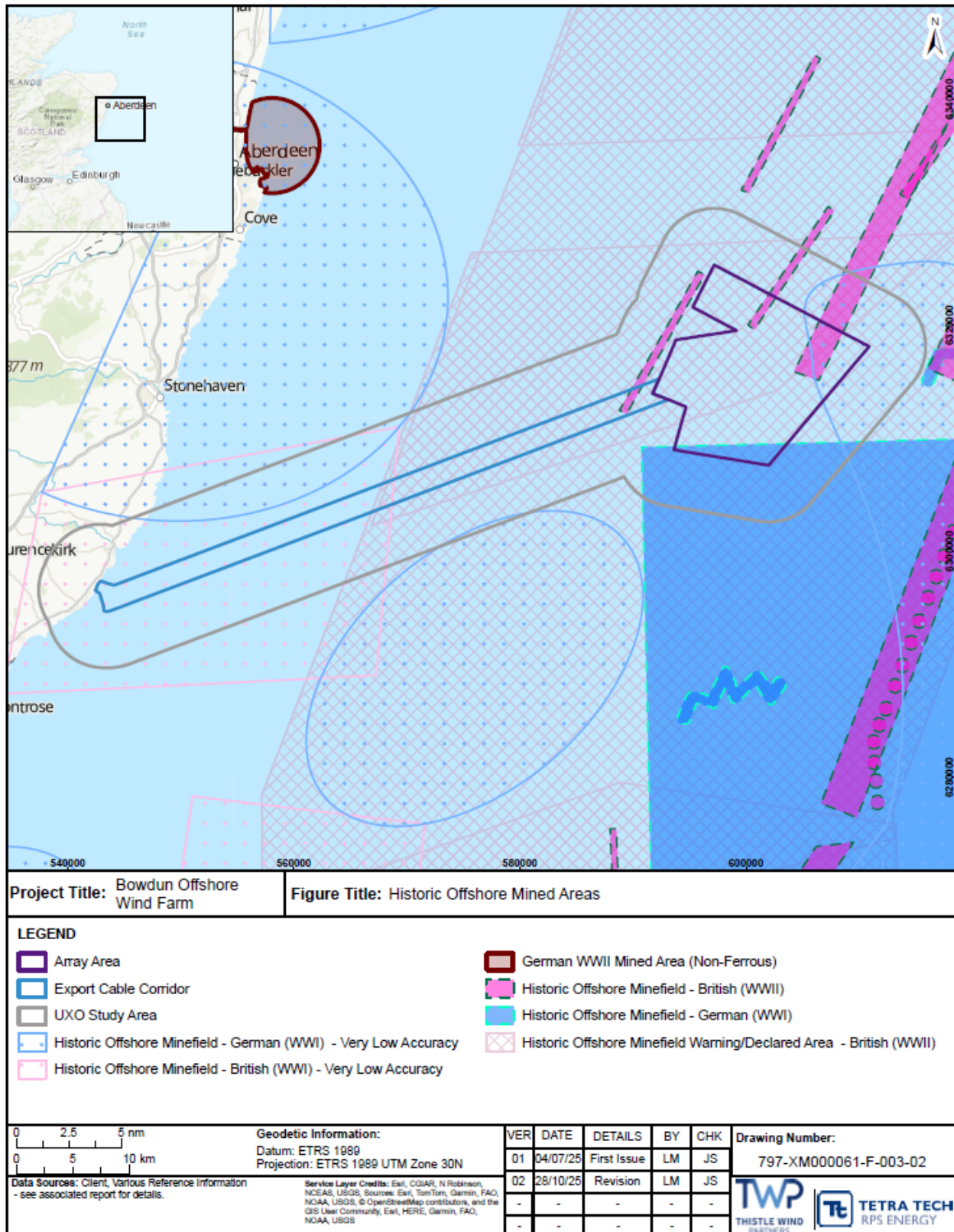


Figure 3.2: Historic Offshore Mined Areas

3.2 Naval Warfare

World War One (WWI) (1914 to 1918)

- 3.2.1 The UXO Study Area lies within the maritime area that was the responsibility of Royal Navy Scottish Coastal Command which was established in 1913 in anticipation of the opening of the Royal Naval dockyard at Rosyth. The main purpose of the command was the provision of the required infrastructure to support the fleet in northern waters. In addition, it provided for maritime local defence from the Moray Firth to the Tyne (Watson, 2015).
- 3.2.2 During WWI with the completion of the construction of the dockyard at Rosyth, from 1915 substantial elements of the Grand Fleet were based in the Firth of Forth which became the main base for the fleet on 12 April 1918.
- 3.2.3 No large-scale naval engagements occurred off the east coast of Scotland during WWI. The UXO Study Area is located approximately 103 km from the major Royal Navy base at the Firth of Forth where from 1915 substantial elements of the Grand Fleet were based. Forces allocated to support the Grand Fleet contained a mixture of those needed for support of the large warships of the Grand Fleet and included destroyer flotillas, a convoy protection flotilla, a submarine flotilla, a sloop flotilla and two minesweeper flotillas (Watson, 2015). As such, significant Naval activity is recorded in the waters of the east coast of Scotland, and this is likely to have included the UXO Study Area. Evidence of Royal Navy and German submarine activity in context with the UXO Study Area are shown in Figure 3.3, Figure 3.4, Figure 3.5 and Figure 3.6.



Figure 3.3: An Example of Royal Navy Movements as Detailed Within German Historical Documents in Context to the UXO Study Area (Blue Line) (Groos, 1920)

3.2.4 German submarines are also recorded as being active in the UXO Study Area during WWI. Details of U-boat activity are listed in Table 3.1 below.

Table 3.1: German WWI Naval Activity in Context with the UXO Study Area (UKHO, 2025)

U-Boat/Ship	Date	Notes
UC-21	August 1914	Patrol
U-41	May 1915	Patrol
U-6	April 1915	Patrol
U-40	23/06/1915	Torpedoed by HM Sub C24 in connection with decoy trawler Taranaki
U-25	25/03/1917	FV Median sunk
U-25	09/07/1915	SS Nordass sunk
UC-77	23/07/1917	SS Sandvick sunk
UC-58	11/02/1918	SS Baku Standard (defensively armed tanker)



Figure 3.4: The Patrol Route (Dashed Blue Line) of German Submarine UC-21 in August 1914 in Context to the UXO Study Area (Blue Line) (Groos, 1920)



Figure 3.5: The Patrol Route (Blue Hatched Area) of German Submarine U-41 in May 1915 in Context of the UXO Study Area (Red Line) (Groos, 1924)

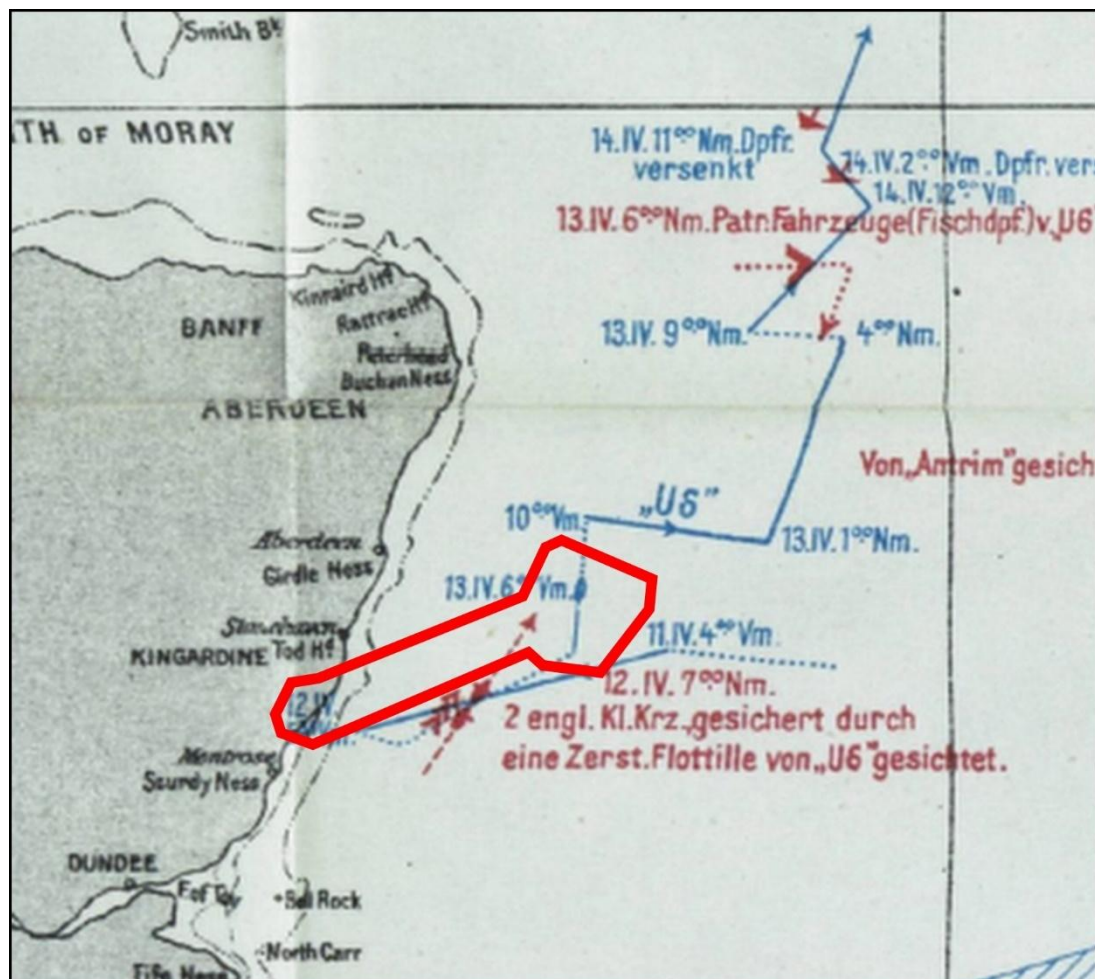


Figure 3.6: The Patrol Route (Blue Line) of the German Submarine U-6 in April 1915 in Context of the UXO Study Area (Red Line) (Groos, 1924)

World War Two (WWII) (1939 to 1945)

- 3.2.5 As in WWI, no large-scale naval engagements occurred off the east coast of Scotland during the WWII, but significant Naval activity, offensive and defensive mining and air activity are recorded as having taken place (The National Archives, 1942; Bundesarchiv-Militärarchiv, n.d.; Air Ministry 1947), as shown in Figure 3.1 and Figure 3.2. During WWII, the UXO Study Area lay within the Naval area of Rosyth Command. Originally activated during WWI, this command had been 'semi-dormant' during the interwar years. It was reactivated in August 1939 and remained one of the major Naval home commands for the rest of the war, and afterwards. Its span of operations extended from Cromarty in the north, down the east of coast of Scotland and north-east England to Flamborough Head. At the outbreak of war, the Rosyth Escort Force was formed. It consisted of a number of sloops and destroyers. The Rosyth Escort Force remained operational throughout the war. The main task of Rosyth Command was the provision of escorts for the northern sector of the east coast convoy system. Another significant role played by the Naval units of Rosyth Command was minesweeping which comprised of seven minesweeping flotillas.

World War Two (WWII) (1939 to 1945) - U-boat Activity

- 3.2.6 U-boat activity during WWII in the areas off the east coast of Scotland was limited and comprised mainly of operations in late 1939. Whilst the Firth of Forth was an area of intense Naval activity, accordingly it was a heavily defended area. As such U-boat operations were focused away from these areas where targets were as plentiful but less heavily defended (e.g., the wider North Atlantic) (NavWeaps, 2024;U-boat.net, 2024).

3.3 Mine Laying Campaigns

World War One (WWI) (1914 to 1918)

- 3.3.1 The east coast of Scotland was a key nautical communication route used by both British merchant and Naval vessels. As such the Germans laid offensive minefields off the coast of Scotland. Two of these minefields are located within the Study Area (Figure 3.2). Records indicate that minefields located off the east coast of Scotland were 'practically cleared' by the 19 August 1918 (Department of the Admiralty, 1918). Subsequent post war clearance activity focused on further North Sea minefield clearance.

World War Two (WWII) (1939 to 1945)

- 3.3.2 To prevent German submarines attacking shipping travelling along the east coast of Britain a large defensive minefield (the East Coast Mine Barrier) was laid running from the Moray Firth south to the entrance of the English Channel in the south (The National Archives, 1942). This was later extended in the north to cover up to the northern part of Scotland. The UXO Study Area is located within this historic minefield (Figure 3.2). Whilst subsequent post war mine clearance activities are recorded; the possibility remains that legacy unexploded mines may still be present in the UXO Study Area from these minefields. Details of ships sunk by mining activity are detailed in Section 3.7.

Post-World War Two (WWII) (1945 to present)

- 3.3.3 There is no information to indicate that mines were employed in the UXO Study Area in the Post-war period. It is possible, however, that inert devices were used for training purposes within the UXO Study Area, and it is therefore possible that isolated devices may be encountered. Mines used for training would be initially indistinguishable from live variants during survey.

3.4 Aerial Conflict and Bombing Campaigns

World War One (WWI) (1914 to 1918)

- 3.4.1 As aviation developed during WWI aircraft were utilised for patrolling at sea as well as being used for reconnaissance purposes. Both fixed wing aircraft (operating from land as well as seaplanes) and airships were used for maritime patrolling. The nearest WWI aviation base in context with the UXO Study Area was a seaplane base located at Dundee (approximately 50 km to the south-west of the UXO Study Area).

World War Two (WWII) (1939 to 1945) – Allied Air Activity

- 3.4.2 During WWII the defence of Scottish maritime and coastal areas was the responsibility of 18 Group RAF Coastal Command. At the outbreak of WWII, the focus was on defensive measures in preparation for an expected invasion. Anti-submarine patrols were carried out as well as convoy protection duties and reconnaissance flights. With the threat of invasion diminishing the focus of Coastal Command, operations expanded to include offensive operations with sorties being flown from Scottish bases to attack targets in occupied Europe and Norway. The nearest Coastal Command airfields in context to the UXO Study Area were located at Dyce (located approximately 37 km to the north-west of the UXO Study Area) and Montrose (located approximately 6 km to the south-west of the UXO Study Area). Air activity related to Coastal Command operations will have taken place in context to the UXO Study Area.
- 3.4.3 Aircraft operated by 18 Group RAF Coastal Command comprised of both British and American types. As such, they would have carried both British and American ordnance types. The aircraft types operated by No.18 Group Coastal Command are shown in Table 3.2. RAF patrol routes are shown in Figure 3.7.

Table 3.2: Aircraft Types Operated by Units of No.18 Group Coastal Command

Unit	Aircraft	US/British	Role
No.144 & 235 Squadrons	Bristol Beaufighter	British	Multi role attack
No.455 (RAAF) and No.489 (RNZAF) Squadrons	Handley Page Hampden	British	Bomber
No.190 Squadron	Consolidated Catalina	US	Flying boat - multi role
No.612 Squadron	Armstrong Whitworth Whitley	British	Bomber
No.540 (Det)	De Havilland Mosquito (PR)	British	Photo reconnaissance
No.1477 Flight	Consolidated Catalina	US	Flying boat - multi role
No.1406 (Meteorology)	Supermarine Spitfire	British	Fighter
No.1406 (Meteorology)	Lockheed Hudson	US	Bomber

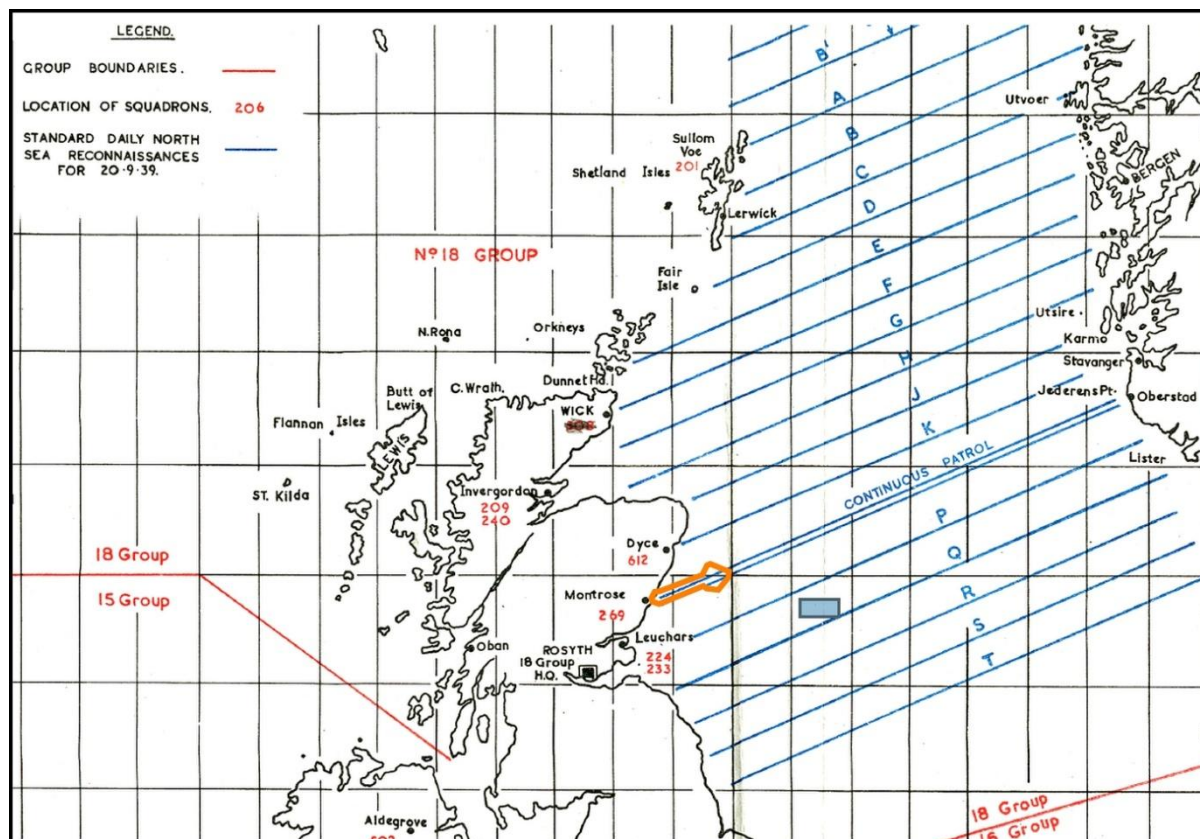


Figure 3.7: RAF Patrol Routes in the North Sea, with the UXO Study Area Shown in Orange (Air Ministry, 1947)

World War Two (WWII) (1939 to 1945) – German Air Activity

3.4.4 Very limited German bombing is recorded in the landfall areas in context to the UXO Study Area. Details of German bombing incidents are provided in Table 3.3.

Table 3.3: WWII Ministry of Home Security Incidents Recorded in Context to the UXO Study Area (The National Archives, n.d.)

Location	Date	Notes
Inverbervie	15/08/1941	At 22.25, 5 High Explosives (HE). fell at Inverbervie. There were no casualties, but house and shop windows were broken.
Inverbervie, Kenneff & Kerloch Hill	05/09/1941	Two HE fell on a farm north of Inverbervie at 17.30. The aircraft fired its machine-guns at Inverbervie Bridge and Railway Station, damaging a telephone line near Kinneff (two miles NE of Inverbervie). No other damage and no casualties are reported. Explosions were heard near Kerloch Hill (12 miles NW of Inverbervie) at 08.45 when enemy aircraft were in the neighborhood, but no further information is to hand.

Post-World War Two (WWII) (1945 to present)

- 3.4.5 No aerial conflict has occurred in the area of the UXO Study Area since the end of WWII. However, the Moray Firth continues to be actively used by military aircraft for training purposes. These uses are outlined in Section 3.9 and displayed in Figure 3.1.

3.5 WWII Defensive Positions (Landfall Area)

- 3.5.1 To protect important locations and to defend against German invasion during WWII, defensive features such as pillboxes, anti-tank ditches and anti-tank blocks were constructed along the Scottish coast. WWII coastal defences comprising of anti-tank blocks and four pillboxes are located in the south and north sections of the UXO Study Area (Pillbox Study Group, n.d.) as shown in Figure 3.1.

3.6 Anti-Aircraft Artillery Positions

- 3.6.1 Research has not identified any Heavy Anti-Aircraft Artillery (AAA) emplacements that could potentially impact the UXO Study Area.

3.7 Shipwrecks and Downed Aircraft

- 3.7.1 Shipwrecks and downed aircraft have the potential to be a source of UXO. It is considered likely that shipwrecks and multiple downed aircraft may have resulted in the creation of UXO from this source within the UXO Study Area.

Shipwrecks

- 3.7.2 A total of 17 shipwrecks that occurred during WWI and WWII have been plotted from United Kingdom Hydrographic Office (UKHO) data along with other data sources within the UXO Study Area. Tetra Tech RPS has examined each record to determine those with a UXO connection (i.e. to establish the location and nature of vessels lost to a mixture of mines, torpedoes, and bombing). The list has also been examined to establish whether any UXO related cargoes may have been carried or whether vessels were scuttled as a result of attacks carried out elsewhere. Twelve are associated with military activity and therefore may pose a potential UXO risk.
- 3.7.3 A full list of these wrecks, with coordinates, is supplied in Table 3.4 and shown visually in Figure 3.8.

Table 3.4. UXO Related Wrecks (UKHO, 2025)

Hydrographic Office (HO) Identifier	Vessel Name	Date Sunk	Latitude	Longitude	Circumstances of Sinking
Unknown	Trawler Queen of Alexandra	13/06/1915	56.866667	-2.033333	Mined
65032	Nordaas	09/07/1915	56.966667	-1.116667	Passage Blyth for Petschora. Sunk by U-25.
Unknown	Athole	17/12/1916	56.857783	-1.976033	Struck British Mine
Unknown	FV Median	25/03/1917	57.040933	- 1.159233	Sunk by UC-25 using time bombs
3176	Sandvik (possibly)	26/03/1917	56.90055	-1.896067	Ex-Temple. Built in 1901 by a Yuyk, Yssel. Owned at time of loss by Tizona, Fredrikstad. One boiler, triple expansion engine of 132hp, single shaft. Passage London for Christiana. Cargo coke. Torpedoed by UC-77.
70430	HMS Repro (probably)	26/04/1917	56.82465	-2.127667	Built in 1910 by Cook, Welton & Gemmel Limited, Beverley. Hired as an armed patrol trawler from February 1915. Struck German mine 3 miles SE of Todhead lighthouse. (sibi).
3064	HMS Repro	26/04/1917	56.84985	-2.143283	Built in 1910 by Cook, Welton & Gemmel Limited, Beverley. Hired as an armed patrol trawler from February 1915. Struck German mine 3 miles SE of Todhead lighthouse. (sibi).
3059	Baku Standard	11/02/1918	56.80865	-2.2152	Built in 1893 by W G Armstrong, Mitchell & Co. Owned at time of loss by John I Jacobs & Co Limited. Two boilers, triple expansion engine of 293nhp, single shaft. Passage the Clyde for the Firth of Forth. Torpedoed by UC-58. (sibi & WWIsl).
3065	Lowdock	19/03/1940	56.884567	-2.053833	Built in 1917. One boiler, triple expansion engine, single shaft. Foundered following collision. (sibi).
3058	Greenawn (possibly)	03/04/1941	56.79995	-2.147	Built in 1924 by Hall, Aberdeen. One boiler, triple expansion engine, single shaft. Passage London for Invergordon. Last seen off Montrose 03 April 1941. Possibly bombed and sunk by German aircraft, since SS Cairnie was bombed and sunk nearby on the same day. (sibi).
3055	Queensbury (possibly)	06/06/1941	56.7856	-2.196717	Built in 1931 by Burntisland Shipbuilding Co, Burntisland. Owned at time of loss by Houlder Line Limited. Three boilers, triple expansion engine,

Hydrographic Office (HO) Identifier	Vessel Name	Date Sunk	Latitude	Longitude	Circumstances of Sinking
					single shaft. Passage Buenos Aires for London. Bombed and set on fire by German aircraft and later capsized. Considered a navigational hazard and sunk by HM Trawler Sturton. 11 men lost. (sibi).
3060	Taurus	06/06/1941	56.82345	-2.15855	Four boilers, triple expansion engine, single shaft. Passage Port Harcourt for Hull. Was taken in tow by HMS Tarantella but was subjected to further air attack. Abandoned by crew and sank. (sibi).
Unknown	SS Bodø	04/01/1943	56.9	- 1.416667	Believed mined
3171	Tanevik	19/01/1945	56.856283	-1.92395	One boiler, triple expansion engine, single shaft. Owned by the Royal Navy as a Barrage balloon vessel. Passage Methil for Buckie, under tow. Foundered. (sibi).

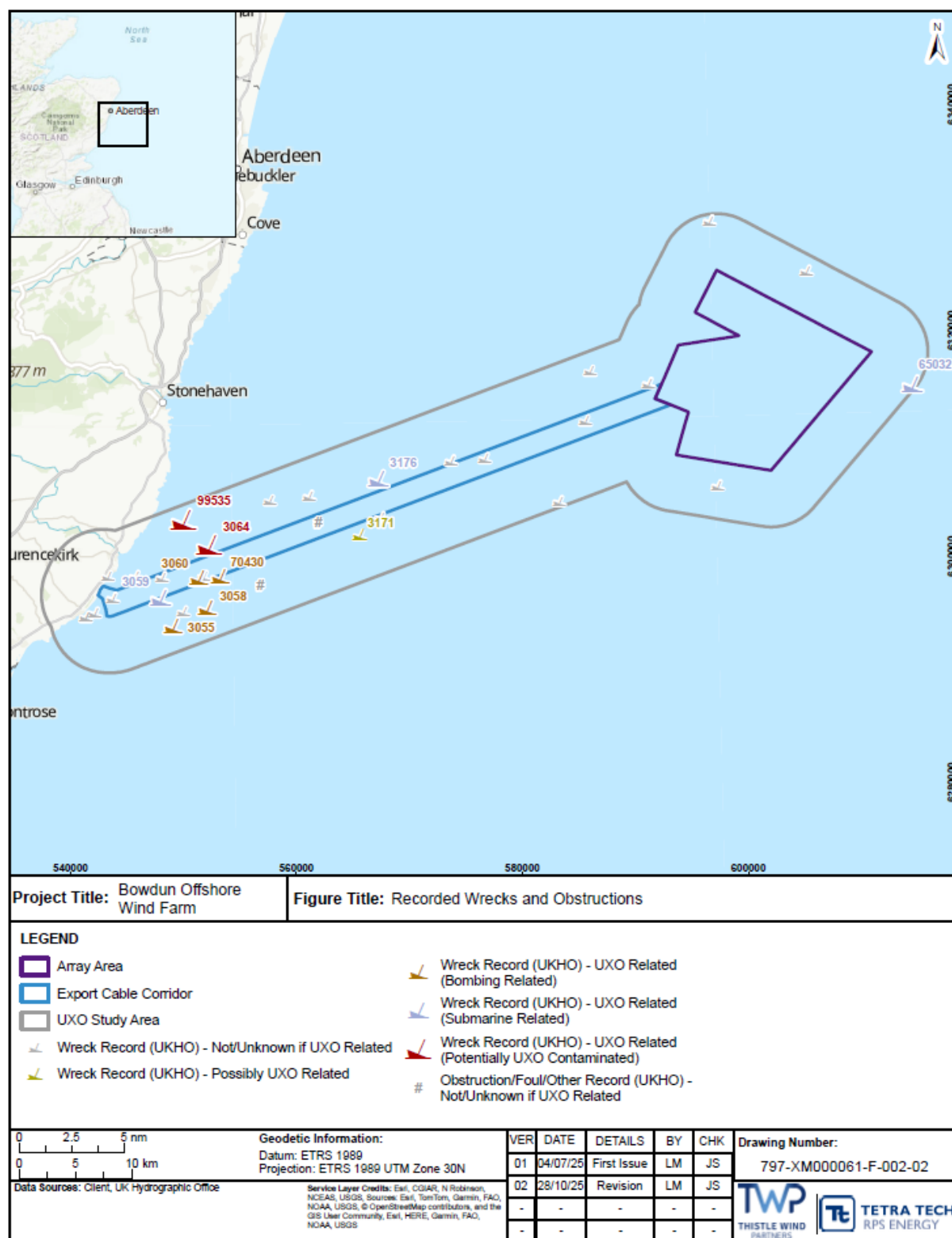


Figure 3.8: Recorded Wrecks and Obstructions

Downed Aircraft

- 3.7.4 During WWII, the *Luftwaffe* carried out numerous attacks on the British mainland. Aircraft performing these attacks on Scotland flew from bases in Northern Europe and Norway. This required a long passage over sea in which the chance of an aircraft being intercepted and shot down increased. Aircraft flying in challenging wartime conditions (e.g. at night and during bad weather, were also prone to accidents and mechanical failures, resulting in crashes). Aircraft in difficulties may also have jettisoned bomb loads to lighten the aircraft. Records of air sea rescue activity detail two air sea rescue tasks carried out in the UXO Study Area; however, it should be noted that the location of air crashes at sea by their nature are often unrecorded or poorly recorded (Wessex Archaeology, 2008).
- 3.7.5 Military aircraft wrecks may have a UXO potential if they were unable to jettison their bombs prior to crashing. Any suspected aircraft wreck should be treated with caution if encountered during the survey. Further, crashed military aircraft are classified as protected remains and it is an offence to knowingly disturb such a wreck without a licence from the relevant authorities. Advice should be sought from the relevant governing bodies (Marine Directorate and Historic Environment Scotland) should there be any requirement to disturb a known or suspected aircraft wreck.

3.8 Coastal Batteries

- 3.8.1 A WWII coastal battery was located at Montrose approximately 8 km to the south-west of the UXO Study Area. This battery was armed with two 6 inch Mk XI/PV guns which were installed in June 1940. The site was put into care and maintenance in April 1945, the guns being removed in October 1945. The maximum range of these guns was 14,000 yards (12,801 m). The guns are not recorded as having been used in action but were likely fired for training, testing and calibration purposes. These firings are likely to have included full calibre (6" projectile) and sub-calibre practice shoots. Some sub-calibre projectiles contain a low explosive bursting charge of black powder, and some are solid shot.

3.9 Current Military Practice Exercise Areas (PEXA)

- 3.9.1 No current military establishments have been identified that may directly influence the UXO Study Area. As such current military establishments will not be considered further in this report.
- 3.9.2 The UXO Study Area is located within non firing practice exercise area (D613).

3.10 Historic Military Sites/Establishments/Ranges

- 3.10.1 No historic military sites/establishments have been identified that may have directly influenced the UXO Study Area. As such historic military sites/establishments military establishments will not be considered further in this report.

3.11 Offshore UXO Dumpsites

- 3.11.1 For decades after the end of both world wars, the disposal of both conventional and chemical weapons at sea was considered best practice. The practice was prohibited with the signing of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters 1972 (often shortened to the ‘London Convention’). However, these dumped munitions remain a real and significant hazard.
- 3.11.2 No munitions dump sites have been identified within the UXO Study Area or in proximity to the UXO Study Area. It should be noted, however, that it was standard practice to dump ordnance at sea and there is widespread evidence that unrecorded dumping took place in coastal waters around Britain at the end of WWI and WWII. Given the presence of large naval groupings in the area, it is possible that dumping took place in the Moray Firth and that UXO will be encountered as a result of these activities.

3.12 OSPAR Munition Encounters/WWII Ministry of Home Security Incidents

- 3.12.1 The Convention for the Protection of the Marine Environment of the North-East Atlantic (the ‘OSPAR Convention’) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992 and was entered into force on 25 March 1998. HM Coastguard records munitions encounters as an ‘incident’ and reports on these incidents, in accordance with the OSPAR Marine Strategy Framework Directive, to the Maritime and Coastguard Agency which have compiled a national OSPAR database for onward reporting to the OSPAR Commission. One OSPAR find is recorded within the UXO Study Area. The munition type is unknown, however it was described as *“found onshore, partly corroded, destroyed”*.
- 3.12.2 During WWII the Ministry of Home Security recorded Civil Defence incidents relating to enemy activity. Three incidents relate to encounters with sea mines in context to the UXO Study Area, which are detailed in Table 3.5.

Table 3.5: WWII Ministry of Home Security Incidents Recorded in Context to the UXO Study Area

Location	Description	Date
Inverbervie	At 0940 hours a mine was washed ashore near Inverbervie, Kincardineshire	02/02/1940
Johnshaven	A mine was observed floating in shore at Johnshaven, Kincardineshire. The Naval authorities were informed, and several houses have been evacuated.	05/11/1940
Gourdon	At 1315 a sea mine exploded at Gourdon (about 10 miles N.N.E of Montrose). Two persons were injured, and damage caused to the roof of a flax-spinning works and to village windows. A further three sea mines have necessitated evacuation of neighboring houses.	02/02/1942

3.13 Post-War Clearance Operations

- 3.13.1 At the cessation of conflict, clearance efforts were made to make the waters safe once more for vessels, utilising the best available technology for that period. After the end of WWI, the Royal Navy lead a joint operation, by all participants, to sweep the minefields within the North Sea area. This involved a cable submerged between two vessels, sweeping the clearance area. The cable sweeping was designed to cut the mooring chain of moored mines and allow the mine to rise to the surface, it was then destroyed by gunfire. It is estimated the operation found only 25% to 30% of the mines laid; it was assumed the others had either broken free, sunk to the bottom, or been destroyed already.
- 3.13.2 The same technology was also employed during WWII, but the clearance of ground mines (which laid on the seabed) was particularly problematic as there were no cables to cut. Techniques of the time involved deliberately inducing detonation of the mines using magnetic and electric based sweep gear; if the mines could not be actuated using sweeping gear, they would be left *in situ* and in all probability remain there until the present day.

4 Baseline Threat Assessment

- 4.1.1 The results of the historical review have been used to conduct a threat assessment to determine the baseline pre-construction and pre-mitigation risk posed by UXO contamination within the UXO Study Area. The assessment outlines the types of UXO that have been identified during the research and assesses the probability of encountering them on site (without considering that any construction activities have already taken place).

4.2 Probability Assessment

- 4.2.1 Each of the types of UXO that have been identified through the research has been assessed and given a Probability of Encounter Grade based on the following Probability Level and Rationale (Table 4.1).

Table 4.1: Probability Assessment Levels

Source Probability Assessment Levels		
Grade	Probability Level	Rationale
A	Highly Probable	Clear evidence that this type of munition would be encountered.
B	Probable	Significant evidence to indicate that this type of munition would be encountered.
C	Possible	Evidence suggests that this type of munition could be encountered.
D	Remote	Evidence suggest that these munitions have been found in the Wider Area of Interest area but not specifically within the UXO Study Area.
E	Improbable	Not considered likely to encounter this type of munition within the UXO Study Area, but not possible to discount completely.
F	Highly Improbable	No evidence that this type of munition would be encountered within the UXO Study Area or the immediate vicinity.

Risk Zoning

- 4.2.2 The probability assessment results will vary across the site due to the geographical extent of the potential UXO sources identified in the research presented above. This results in a different risk profile across the site based upon these affected areas. The Site Boundary was divided into Risk Zones based upon the probability assessment results (in addition to planned activities and water depths) in order to ensure that a pragmatic approach is taken to the risk of each ordnance type across the site. The results of the probability assessment are shown in Table 4.2. Risk Zoning is shown graphically in Figure 4.1. The sources of UXO which influence the risk zoning and probability assessment are shown graphically in Figure 3.1 and Figure 3.2 and detailed in Section 6.1. The probability of encountering munitions during geotechnical investigation activities is reduced when compared to installation activities due to the more limited interaction of equipment with the seabed.

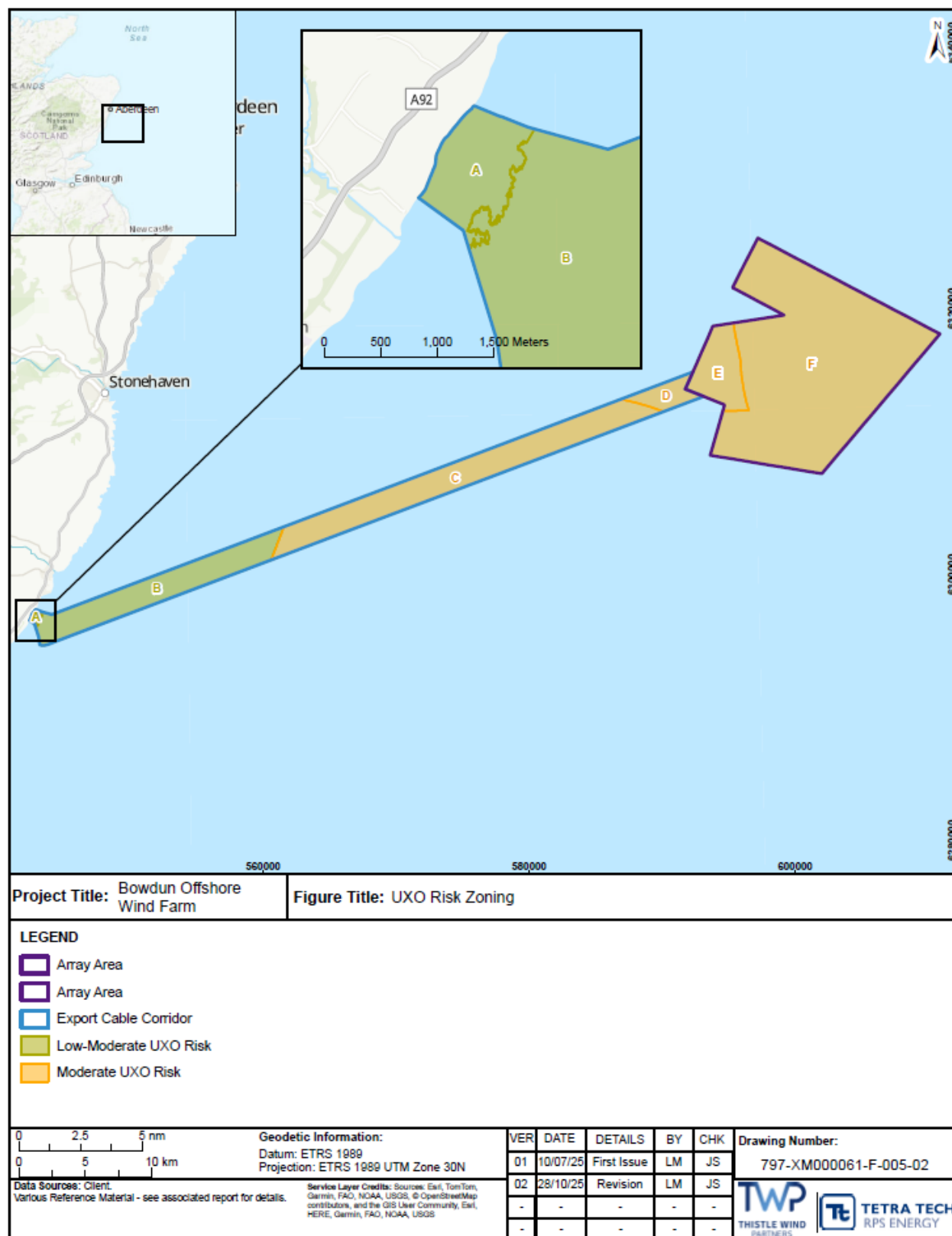


Figure 4.1: UXO Risk Zoning

Probability Assessment Results

4.2.3 The results are shown in Table 4.2.

Table 4.2: Probability of Encounter for Each Assessed Ordnance Variety, Based on the Research Provided in the Prior Sections

Probability Assessment Levels							
UXO		Risk Zone					
		A	B	C	D	E	F
Small Arms Ammunition		D	E	E	E	E	E
Land Service Ammunition		D	E	E	E	E	E
≤155 mm Projectile		D	D	D	D	D	D
>155 mm Projectile		D	D	D	D	D	D
HE Bombs	Allied Origin	D	D	D	D	D	D
	German Origin	D	D	D	D	D	D
Sea Mines	Allied Origin – Contact Mines	D	D	C	C	C	C
	Allied Origin – Ground Mines	E	E	C	C	C	C
	German Origin – Contact Mines	D	D	D	E	E	C
	German Origin – Ground Mines	E	E	E	E	E	E
Land Mines		E	E	E	E	E	E
Torpedoes		D	D	D	D	D	D
Depth charges		D	D	C	C	C	C
Dumped Conventional Munitions		D	D	D	D	D	D
Dumped Chemical Munitions		E	E	E	E	E	E
Missiles/Rockets		D	D	D	D	D	D

5 UXO Analysis and Assessment

5.1 General

- 5.1.1 A risk assessment is a formalised process for assessing the level of risk associated with a particular situation or action. It involves identifying the hazards and the potential receptor that could be affected by the hazard. The degree of risk is associated with the potential for a pathway to be present, linking the hazard to the receptor. This relationship is usually summarised as the Source – Pathway – Receptor.
- 5.1.2 The assessment has utilised information provided in Section 3 and included the proposed intrusive activities to propose a more specific and detailed mitigation methodology.

5.2 Sources/Hazards

- 5.2.1 Based on the information collated, the following types of ordnance have the potential to have been utilised on/within the vicinity of the Proposed Development:
- small arms ammunition;
 - land service ammunition;
 - projectiles;
 - HE bombs;
 - sea mines;
 - torpedoes;
 - depth charges;
 - dumped conventional munitions; and
 - missiles/rockets.
- 5.2.2 It should be considered that WWI and WWII munitions will be found on or below the sea floor that are still hermetically sealed, with no water ingress. Other devices may, however, be cracked, with the outer casings of some mines, for example, worn away over time. Therefore, it is not possible to state with any certainty that historic munitions pose less of a risk based on their degradation over time.

5.3 Pathway

- 5.3.1 The pathway is described as the route by which the hazard reaches the receptor. Given the nature of the proposed works, the only pathways would be during the following activities:
- cable laying;
 - ploughing;
 - tracked vehicle jetting;

- chain cutter;
- snag on vessel;
- dredging;
- backhoe dredger;
- MFE;
- HDD;
- anchoring;
- jack-up operations;
- piling;
- suction bucket foundations;
- rock placement;
- mattress installation;
- peel grab operations;
- PLGR;
- borehole/vibrocore;
- CPT; and
- grab sampling.

Note: It is not expected that all activities listed above will take place during construction.

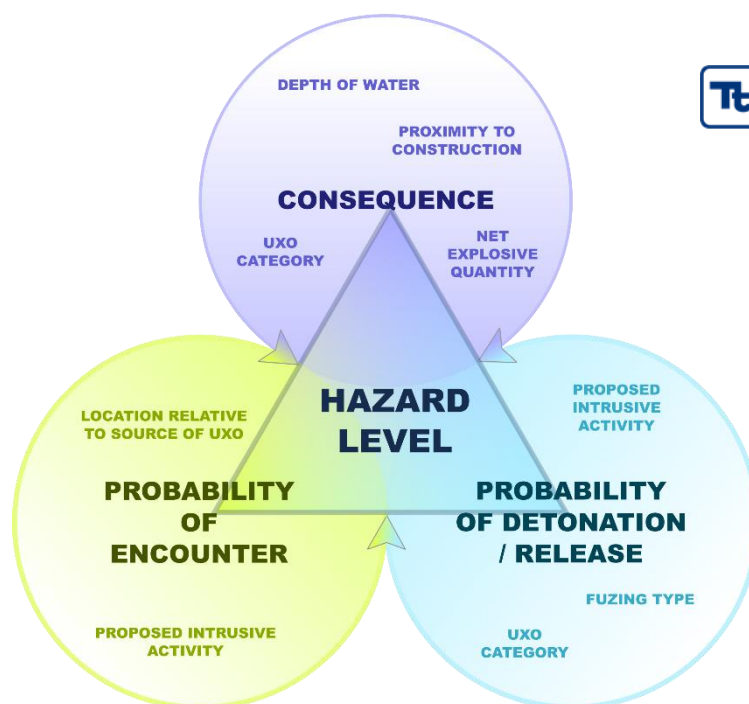
5.4 Receptors

5.4.1 Sensitive receptors applicable to this proposed route would be:

- people (workers/engineers and the general public);
- high-value equipment;
- infrastructure;
- vessels (including public); and
- environment (marine mammals, fish and shellfish, etc.).

5.5 Risk Evaluation

5.5.1 The following sections contain the Risk Evaluation for the Proposed Development, prior to the implementation of any risk mitigation measures. For the risk to be properly defined, several factors must be taken into account, including the consequences of initiation, the probability of encountering UXO on the Proposed Development and the probability of detonating munitions during intrusive activities. The technique used to evaluate level of risk is outlined in Figure 5.1.



$$\text{Risk level} = \text{Probability of Encounter} \times \text{Probability of Detonation or Release} \times \text{Consequence}$$

Figure 5.1: Hazard Level Considerations

5.5.2 If a significant risk is identified, an appropriate risk mitigation strategy is necessary for the intended activity. A semi-quantitative assessment is completed in Section 5.6 to identify the risk.

5.6 Probability and Consequence Assessment

5.6.1 For the purpose of this assessment, the Probability of Encounter and Detonation and the potential subsequent Consequence of Detonation for the specific proposed works to be undertaken during the Proposed Development has been examined. Only the main categories of munitions have been included to provide a range of assessment data, and it should be noted that other munition types may remain in the area.

5.6.2 The assessment is presented at Annex A and the process detailed in Paragraphs 5.6.3 *et. seq.*

Probability of Encounter Assessment

5.6.3 An estimate of the likelihood of a UXO risk being present within each Risk Zone is made to assess the Probability of Encounter, which are ranked A to F, as below.

- A – Highly Probable (1);
- B – Probable (0.1);
- C – Possible (0.01);

- D – Remote (0.001);
- E – Improbable (0.0001); and
- F – Highly Improbable (0.00001).

Probability of Detonation Assessment

5.6.4 The Probability of Encounter is combined with the probability of a certain munition type detonating, the Probability of Detonation. The probability of each engineering activity causing each munition type to detonate is assessed and ranked A to F:

- A – Highly Probable (1);
- B – Probable (0.1);
- C – Possible (0.01);
- D – Remote (0.001);
- E – Improbable (0.0001); and
- F – Highly Improbable (0.00001).

5.6.5 This is based on the estimated disturbance caused by the installation activity and the likelihood for this to cause a detonation of specific munitions (which is based on the items initiation systems).

Consequence Assessment

5.6.6 Finally, the consequence level for each activity and munition type is obtained from the table presented in Annex B, which provides a consequence rating from one to five, depending upon the severity. The detonation consequence assessment assigns a site-specific consequence level to any potential UXO (pUXO) that may be encountered at the proposed route. This is achieved by combining the UXO impact ranking and the depth of water across the Proposed Development. A rating system for assigning consequence levels has been derived based on the expected effects of a detonation event during each of the engineering activities, both on the seabed and on the vessel.

Risk Level

5.6.7 The result for each activity, munition type and segment are then presented as: $P_E \times P_D \times C$; where:

- P_E is the Probability of Encounter level, (A to F);
- P_D is the Probability of a Detonation level (A to F); and
- C is the Consequence of a Detonation level (one to five).

5.6.8 The Probability of Encounter, Probability of Detonation and Consequence of a Detonation levels are then multiplied to give a Risk Level for each munition type, segment and engineering activity.

5.6.9 This was determined by assigning the values in the following tables (Table 5.1, Table 5.2 and Table 5.3) to the above results, which were then multiplied to provide a final Risk Level ranging between Negligible and High.

Table 5.1: Probability and Consequence Levels

Probability of Encounter (1)		Probability of Detonation (2)		Consequence of Detonation (3)	
A	Highly Probable (1)	A	Highly Probable (1)	1	Catastrophic (1.00)
B	Probable (0.1)	B	Probable (0.1)	2	Major (0.1)
C	Possible (0.01)	C	Possible (0.01)	3	Moderate (0.01)
D	Remote (0.001)	D	Remote (0.001)	4	Minor (0.001)
E	Improbable (0.0001)	E	Improbable (0.0001)	5	Insignificant (0.0001)
F	Highly Improbable (0.00001)	F	Highly Improbable (0.00001)		

Table 5.2: Example Risk Score and Associated Risk Rating (Full Details in Annex A)

		Probability of Encounter, P_E					
$C = 1$		A	B	C	D	E	F
Probability of Detonation, P_D	A	AA1	BA1	CA1	DA1	EA1	FA1
	B	AB1	BB1	CB1	DB1	EB1	FB1
	C	AC1	BC1	CC1	DC1	EC1	FC1
	D	AD1	BD1	CD1	DD1	ED1	FD1
	E	AE1	BE1	CE1	DE1	EE1	FE1
	F	AF1	BF1	CF1	DF1	EF1	FF1

Table 5.3: Definition of Risk Levels

Risk Level	Definition
High	Indisputable evidence that there is a risk from this type of UXO in the area. Proactive UXO Mitigation is required.
Moderate	Evidence suggests that there is a risk from this type of UXO in the area. Proactive UXO Mitigation is required.
Low-Moderate	Some evidence suggests that there is a risk from this type of UXO in the area. The Probability and Consequence of Detonation increase the risk posed by these items. Proactive and/or reduced Reactive Mitigation is required.
Low	Some evidence suggests that there is a risk from this type of UXO in the area or wider region. Reactive mitigation may be required.
Negligible	No evidence suggesting that there is a risk from this type of UXO in the area or wider region. No further mitigation is required.

6 UXO Risk Levels

6.1 UXO Risk

- 6.1.1 As per Figure 5.1, the category of UXO, both when assessing the probability of the item functioning and the consequence of such an event, has been taken into account. This leads to the varying risk levels between munitions with the same installation methodology. The full risk matrices are presented in Annex A providing an assessment of the risk associated with each activity.
- 6.1.2 The Site Boundary has been split into 6 zones (A to F), dependent on the risk presented and the planned installation activities. Table 6.1 shows the maximum risk for each zone. Descriptions of the zones are given in Section 6.1. Risk Zoning is shown graphically in Figure 6.1.

Table 6.1: Overall Risk Level

Overall Risk Level							
UXO		Risk Zone					
		A	B	C	D	E	F
Small arms ammunition		Low	Low	Low	Low	Low	Low
Land service ammunition		Low	Low	Low	Low	Low	Low
≤155 mm projectile		Low	Low	Low	Low	Low	Low
>155 mm projectile		Low	Low	Low	Low	Low	Low
HE bombs	Allied origin	Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
	German origin	Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
Sea Mines	Allied origin – contact mines	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
	Allied origin – ground mines	Low	Low	Mod	Mod	Mod	Mod
	German origin – contact mines	Low-Mod	Low-Mod	Low-Mod	Low	Low	Mod
	German origin – ground mines	Low	Low	Low	Low	Low	Low
Land mines		Low	Low	Low	Low	Low	Low
Torpedoes		Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
Depth charges		Low-Mod	Low	Mod	Mod	Mod	Mod
Dumped conventional munitions		Low-Mod	Low	Low	Low	Low-Mod	Low-Mod

Overall Risk Level						
Dumped chemical munitions	Low	Low	Low	Low	Low	Low
Missiles/rockets	Low	Low	Low	Low	Low	Low

- 6.1.3 Based on the conclusions of the research and the risk assessment undertaken, a varying **Low-Moderate** and **Moderate** risk from encountering UXO has been identified within the Site Boundary. The risk is primarily due to the potential presence of HE bombs, sea mines, torpedoes and depth charges.

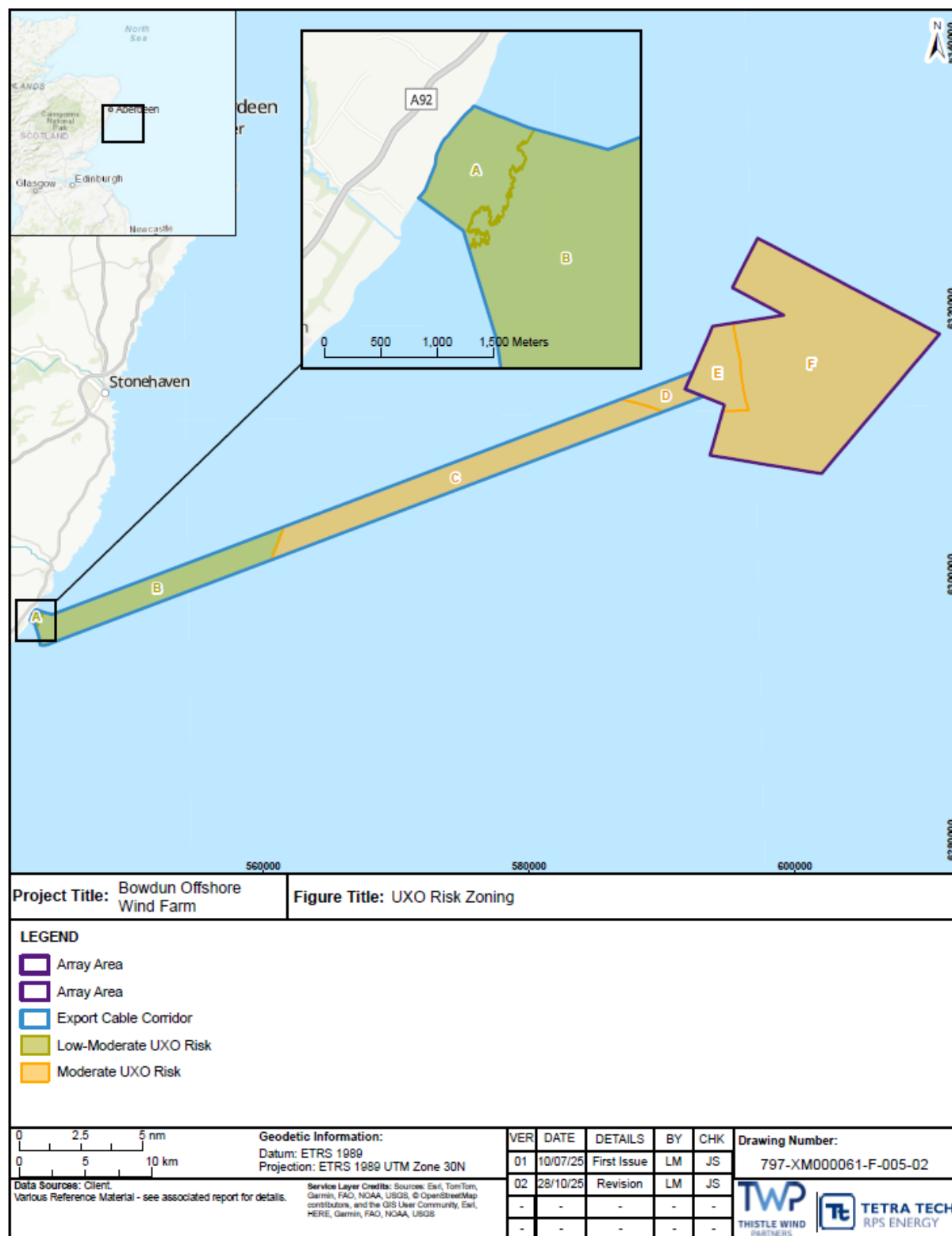


Figure 6.1: UXO Risk Zoning

Zone A – Low-Moderate Risk

Offshore Export Cable Corridor in Water Depth Ranging from 0 m to 10 m

- 6.1.4 This zone represents the area of the Export Cable Corridor which lies in water depth ranging from 0 m and -10 m. This zone lies within large-scale British and German WWI minefields, as such there is the potential to encounter contact mines in this area. Additionally, there is the potential to encounter HE bombs in this zone, associated with the numerous airfields inland of the Landfall site (aircraft may have jettisoned bombs on way into or out of the airbases). There is a residual risk of encountering munition associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Zone B – Low-Moderate Risk

Offshore Export Cable Corridor from -10 m Water Depth to Western Boundary of Historic Offshore Minefield Warning Declared Area – British (WWII)

- 6.1.5 This zone represents the area of the Offshore Export Cable Corridor which lies between -10 m water depth and the western boundary of the Historic Offshore Minefield Warning Declared Area – British (WWII). This zone lies within large-scale British and German WWI minefields, as such there is the potential to encounter contact mines in this area. Additionally, there is the potential to encounter HE bombs in this zone, associated with the numerous airfields inland of the Landfall site (aircraft may have jettisoned bombs on way into or out of the airbases). There is a residual risk of encountering munition associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Zone C – Moderate Risk

Historic Offshore Minefield Warning Declared Area – British (WWII) to Eastern Boundary of German WWI Minefield

- 6.1.6 This zone represents the area of the Offshore Export Cable Corridor which lies between the western boundary of the Historic Offshore Minefield Warning Declared Area – British (WWII) and the eastern boundary of the German WWI Minefield. This zone lies within the Historic Offshore Minefield Warning Declared Area – British (WWII), as such there is an increased potential to encounter British contact and ground mines. Additionally, this zone lies within large-scale German WWI minefields, therefore there is the potential to encounter German contact mines. There is also the potential to encounter munitions associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Zone D – Moderate Risk

Eastern Boundary of German WWI Minefield to Array Area

- 6.1.7 This zone represents the area of the Offshore Export Cable Corridor which lies between the western boundary of the Historic Offshore Minefield Warning Declared Area – British (WWII) and the eastern boundary of the German WWI Minefield. This zone lies within the Historic Offshore Minefield Warning Declared Area – British (WWII), as such there is an increased potential to encounter British contact and ground mines. There is also the potential to encounter munitions associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Zone E – Moderate Risk

Array Area Lying Outside German Minefields

- 6.1.8 This zone represents the portion of the Array Area which lies outside known German minefields. This zone lies within the Historic Offshore Minefield Warning Declared Area – British (WWII), as such there is an increased potential to encounter British contact and ground mines. There is also the potential to encounter munitions associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Zone F – Moderate Risk

Array Area Lying Within German Minefields

- 6.1.9 This zone represents the portion of the Array Area which lies within known German minefields. This zone lies within the Historic Offshore Minefield Warning Declared Area – British (WWII), as such there is an increased potential to encounter British contact and ground mines. Additionally, this zone lies within German WWI minefields, therefore there is the potential to encounter German contact mines. There is also the potential to encounter munitions associated with anti-shipping and anti-submarine warfare, including projectiles, torpedoes, depth charges and rockets.

Risk Level by Activity

- 6.1.10 The Risk Level in each zone varies depending on the construction/installation activities being undertaken as well as the types of ordnance expected in each zone. As outlined in Section 5.6, the Risk Level for each ordnance type and each activity is determined using the Probability of Encounter, Probability of Detonation and Consequence of Detonation.
- 6.1.11 The Probability of Detonation varies between installation activities as each activity interacts with the seabed in a different way, either increasing/reducing the chance of the equipment/asset interacting with pUXO or increasing/decreasing the amount of energy transferred from the equipment/asset to pUXO, which may result in a detonation. For example, a plough (as it is intrusive and higher energy) has an increased Probability of Detonation compared to a non-intrusive activity, such as surface cable lay. The second factor which changes between activities is the Consequence of Detonation. This is because the potential consequences of striking UXO with a

plough on the seabed towed behind the boat is significantly lower than if UXO were snagged on equipment and brought to deck (snag on vessel).

6.1.12 The Risk Level of each potential activity/pathway within each Risk Zone are shown in Table 6.2.

Table 6.2: Risk Level by Activity and Risk Zone

Risk Level by Activity						
Activity/Pathway	Risk Zone					
	A	B	C	D	E	F
Cable lay	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Ploughing	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Vessel mounted jetting	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Tracked vehicle jetting	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Chain cutter	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Snag on vessel	Low-Mod	Low	Low-Mod	Low-Mod	Low-Mod	Mod
Dredging	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Backhoe dredger	Low-Mod	-	-	-	-	-
HDD	Low-Mod	-	-	-	-	-
MFE	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Anchoring	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Jack-up operations	Low-Mod	-	-	-	Mod	Mod
Piling	-	-	-	-	Mod	Mod
Suction bucket foundations	-	-	-	-	Mod	Mod
Rock placement	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
Mattress installation	Low	Low	Low	Low	Low	Low
Peel grab operations	Low	Low	Low	Low	Low	Low
Boulder Plough	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
PLGR	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod

Risk Level by Activity						
Vibrocore/ borehole	Low	Low	Low-Mod	Low-Mod	Low-Mod	Low-Mod
CPT	Low	Low	Low-Mod	Low-Mod	Low-Mod	Low-Mod
Grab sampling/ environmental sampling	Low	Low	Low	Low	Low	Low

7 Data Review

7.1.1 Geophysical survey data covering 1 km width of the Export Cable Corridor and the Array Area has been provided for use in this UXO Desktop Study in order to determine likely munition burial depths. The pertinent details can be found in Volume 2, Chapter 7: Physical Processes and summarised below.

7.1.2 The geophysical survey was conducted by G-tec across a number of campaigns. The Export Cable Corridor was surveyed in campaigns between September 2023 and October 2023, and March 2024 and June 2024 by the vessel *Ondine Jule* and by the vessel *Manor Brunel* in three campaigns in May and June 2023. Survey of the Array Area was conducted in four campaigns by *Mainport Geo* and *Karina*, in March 2023, June 2023, August to October 2023 and May to September 2024. Multibeam Echosounder (MBES), Sidescan Sonar (SSS), Magnetometer (MAG) and Sub-bottom Profiler (SBP) data were collected.

7.2 Bathymetry

7.2.1 The water depth across the Export Cable Corridor is shown to range between -0.13 m water depth and -112.7 m water depth. As the cable route extends from the Landfall, the water depth is expected to increase relatively rapidly, reaching -10 m water depth at ~-300 m from Landfall. From here, the water depth increases steadily to a depth of ~-50 m at approximately 8 km from Landfall. The seabed plateaus before descending again approximately 20.5 km from the Landfall. The maximum water depth of -112.7 m is reached approximately 30.2 km from Landfall. The water depth then increases to ~70 m, before deepening once more to ~-100 m water depth. The seabed shallows to reach -68 m water depth as the Export Cable Corridor meets the Array Area.

7.2.2 The water depths within the Array Area range from -53.39 m water depth to -91.47 m water depth. The shallowest water depths on site are expected in the central northern portion of the Array Area.

Mobile Sediment Bedforms

7.2.3 Sandwaves are seen across both the Array Area and the Export Cable Corridor, with sandwave heights of up to 6 m.

7.2.4 Areas of ripples and megaripples have been identified across the UXO Study Area. These are present throughout the Array Area, and across the majority of the Export Cable Corridor, with exception of 4 km of the route closest to shore. The ripples typically have a height of up to 10 cm, whilst the megaripples can reach heights of up to 50 cm.

7.3 Seabed Sediments

- 7.3.1 As outlined in the Volume 2, Chapter 7: Physical Processes, the seabed sediments across the UXO Study Area are for the most part sands and silty sands. Areas of glacial till are seen throughout the Export Cable Corridor. In the nearshore section of the Export Cable Corridor, the seabed is described as rocky.
- 7.3.2 Boulders are seen throughout the Export Cable Corridor, particularly in areas where the seabed is described as glacial till. Boulder fields are also observed across the Array Area.

7.4 Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS) and Magnetometer (MAG) Targets

- 7.4.1 A large number (120,648) of SSS contacts over 0.3 m were detected within the Export Cable Corridor. However, the vast majority of these (119,290) are identified as boulders. A further 844 were identified as probable boulders. 461 were identified as possible debris, 40 as possible linear debris, 11 as depressions and two as known wrecks.
- 7.4.2 Within the Array Area, a total of 13,858 SSS were identified. Of these, 13,263 were identified as boulders, with a further ten identified as probable boulders. 386 were identified as possible debris, 43 as possible linear debris, 155 as possible fishing equipment and one as an abandoned well.
- 7.4.3 A total of 1,345 MAG contacts were identified within the Export Cable Corridor with a further 930 identified in the Array Area.
- 7.4.4 During a UXO Survey, the primary sensor utilised in the detection of pUXO targets is the MAG sensor. It should be noted that the survey conducted was a standard site geophysical survey, and as such the line spacing (ranging from 15 m to 50 m) and altitude of the MAG sensors (often higher than 5 m above the seabed) are beyond what is required during a UXO survey. The high line spacing and sensor altitudes result in reduced detection into the seabed, and also large gaps in data between survey lines due to the detection range of the sensors. This means that between lines of data, there may be UXO that are not detected at all, and additionally on lines of data there may be UXO buried to such a depth that they are not detected. Therefore, the MAG data is not suitable for comprehensive UXO identification.

8 Marine UXO Migration/Drift and Burial

8.1 Migration/Drift

- 8.1.1 Numerous studies have documented that munitions can migrate across the seafloor; the main force behind this movement is tidal currents. Research by Wilson *et al.* (2008) highlights that the migration of munitions decreased with burial depth, with munitions in a minimal burial state being particularly susceptible to movement when influenced by a large wave or strong current. Importantly, Wilson *et al.* (2008) report states that once a munition is completely buried, no further migration occurs unless bottom profile variation allows for re-exposure or there is scour.
- 8.1.2 The greater the tidal current or current velocity, the greater the likelihood and rate at which UXO items can migrate. However, larger items of UXO such as mines, torpedoes and larger categories of bombs, are unlikely to migrate as far and frequently as smaller items, as they require significant tidal/current velocities to exceed the minimum energy for them to move. Smaller items of UXO, such as AAA projectiles and small arms ammunition, are more likely to migrate when subjected to lower levels of energy generated by more benign tides and currents.
- 8.1.3 Additionally, munitions tend to gather in seabed hollows (they roll in, but tidal action is sometimes insufficient to roll them out again). Shoals of fish tend to congregate in seabed hollows too (as they avoid strong currents in slack water) and fishing trawlers trying to catch them are occasionally prone to snagging UXO in their nets bringing them to the surface. Interaction with the seabed from fishing activities are therefore a possible vector for UXO migration.
- 8.1.4 A report (Menzel, Wranik and Paschen, 2017), which considers the critical velocities needed to move certain objects at various points of burial has been considered. The items considered were:
- British Depth Bomb Mark 1;
 - British 250 lb General Purpose Bomb;
 - German Mine Type GU; and
 - German Mine Type GY.
- 8.1.5 The critical velocities in m/s are presented in Table 8.1 for the various statuses of burial.

Table 8.1: Critical Velocities

Item	Critical Velocity @ 5% Burial (m/s)	Critical Velocity @ 15% Burial (m/s)	Critical Velocity @ 30% Burial (m/s)	Critical Velocity @ 50% Burial (m/s)
Mark 1	1.2	1.5	1.9	2.2
250 lb General Purpose Bomb	1.6	2	2.4	2.7
GU Mine	1.8	2.1	2.5	3.3
GY Mine	2.2	2.7	2.9	3.9

8.1.6 The results show scenarios with conservative assumptions, and it should be noted that the following assumptions have been made:

- a sandy, non-cohesive seabed is required;
- the objects must be at least partially buried;
- an accumulation area is formed in the wake of the objects;
- flow through the sediment is neglected;
- the influence of surface waves is neglected;
- ripples, dunes and the overall shape of the seabed are constant;
- the influence of the water column above the object is neglected; and
- the value of the incident velocity is defined 20 cm above the seafloor in realistic scale.

8.1.7 The results show that the larger an item is and the greater its mass, the larger the tidal current or current velocity must be to move it.

8.1.8 The most appropriate surrogate for the ordnance expected within the site would be the British Depth Bomb Mark 1, which mobilises at 1.2 m/s when 5% buried. Although no current data has been provided, Tetra Tech RPS has consulted open-source ocean current data which indicates that the current velocity is expected to be a maximum of ~0.75 m/s. The maximum current velocity on site is lower than the critical velocity noted in Table 8.1. Therefore, it is concluded that seabed currents are not sufficient to cause the migration of UXO.

8.2 Depth of Burial

Burial via Initial Penetration

- 8.2.1 When a munition is fired/dropped from height, its velocity upon initial impact provides the potential for the item to penetrate the seabed. In situations where a device impacted into >-10 m depth of water, it is likely that penetration would have been retarded significantly by the water and the ordnance would come to rest on or very near the seabed (within the top 2 m). Given the water depths located throughout the site, it is considered unlikely munitions would have become buried when coming to rest on the seabed.
- 8.2.2 Certain munitions, including those that have either been dumped, placed (i.e. sea mines) or have migrated from elsewhere, are likely to have landed on the surface of the seabed rather than penetrating.

Burial via Natural Processes

- 8.2.3 In the softer sediments, it is possible for munitions to be covered by shifting sediments on the seabed and subsequently become buried. This is dependent on the mass, dimensions/shape of the item and the sediments upon which it came to rest as well as the currents affecting the area, however the maximum burial depth due to scour is approximately equal to the diameter of the munition. Burial is not possible in areas where bedrock is exposed.
- 8.2.4 Given the water depths throughout the site, it is considered likely that burial via natural processes (i.e. mobile seabed) will be the main form of burial rather than burial as a direct result of penetration upon impact.

Sediment Mobility

- 8.2.5 Ripples, megaripples and sandwaves have been identified across the UXO Study Area. These features are up to 6 m in height and so may cause additional burial of munitions up to this height.

Depth of Burial Analysis

- 8.2.6 It has been determined that for the majority of the site, burial via natural processes will be the primary mechanism of burial. Where mobile sediment bedforms are not present, the depth of burial is likely to be limited to scour depth (approximately equal to the diameter of the munition). Where mobile sediment bedforms are present, munition burial could be increased by up to the maximum height of the bedform. Where bedrock is at the seabed surface burial is not expected.

9 Risk Mitigation Strategy

9.1 Mitigation Strategy Rationale

- 9.1.1 The risk assessment for pUXO contamination has identified a risk from UXO on site (Table 9.1). The research completed established that there is a Moderate UXO risk within the UXO Study Area as the following three components are present:
- **Source:** A UXO risk that exists;
 - **Detonation Pathway:** A mechanism that may cause UXO to detonate; and
 - **Receptors:** These would be at risk of experiencing an adverse response following the detonation of a munition.
- 9.1.2 The purpose of risk mitigation is to take action to address one or more of these components to reduce the probability of an incident occurring or to limit the impact of the problem if it does occur; thereby, eliminating the risk or reducing the risk to an acceptable level, or 'ALARP'.
- 9.1.3 Obviously, the most effective method of mitigation is to remove the source of the contaminant. However, where this is not feasible, it may be necessary to look at alternative methodologies, such as avoiding a suspect item, removing the detonation pathway or minimising the risks to the receptors.

Table 9.1: Risk Mitigation Strategy Overview

Risk Zone	Activity/Risk Level*	Mitigation Required						
		UXO Survey	Non-Ferrous Survey	Avoidance and/or Identification and Clearance (ID&C)	Explosive Safety Briefing	Explosives Engineer on Vessel**	Explosives Engineer On-Call	Detection Requirement
A	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
B	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
C	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
	Moderate risk activities	✓		✓	✓			50 kg
D	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
	Moderate risk activities	✓		✓	✓			50 kg

Risk Zone	Activity/Risk Level*	Mitigation Required						
		UXO Survey	Non-Ferrous Survey	Avoidance and/or Identification and Clearance (ID&C)	Explosive Safety Briefing	Explosives Engineer on Vessel**	Explosives Engineer On-Call	Detection Requirement
E	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
	Moderate risk activities	✓		✓	✓			50 kg
F	Low risk activities				✓			N/A
	Low-Moderate risk activities			✓	✓			See Section 10.1
	Moderate risk activities	✓		✓	✓			50 kg

* See Table 6.2 for Risk Level of each activity in each Risk Zone.

** Dependent on Survey Results.

For further information about Primary Mitigation requirements see Section 10.

For further information about Tertiary Mitigation requirements see Section 13.

10 Primary Mitigation

10.1 UXO Survey

- 10.1.1 Where reasonably practicable to do so, a UXO survey will be undertaken to identify pUXO prior to intrusive activities taking place on/below the seabed.
- 10.1.2 Importantly, although every endeavour can be made to ensure that the seabed is clear of UXO prior to works taking place, it should be recognised that there can never be 100% clearance, as there is always the potential for munitions to be missed during survey due to limitations with the equipment and site conditions (i.e. existing cables) as well as for UXO to migrate into the area after the survey is complete.

Mitigation for Geotechnical Investigation

- 10.1.3 The probability of encountering munitions during geotechnical investigation activities is already reduced when compared to installation activities, due to the more limited interaction of equipment with the seabed. As the intrusive tool (CPT cone, vibrocore, etc.) represents an even smaller proportion of the seabed, geotechnical apparatus when compared with the geotechnical seabed frame, the probability of encountering UXO with the intrusive tool is further diminished. Therefore, the Low-Moderate risk to geotechnical investigation activities identified in a number of zones would predominantly be as a result of items of UXO lying on the surface.
- 10.1.4 Therefore, the primary form of mitigation would be the avoidance of surface targets in MBES and SSS datasets (as is standard practice during a geotechnical investigation campaign), with the use of MAG data, where possible, to further reduce the residual risk from buried UXO.

MBES/SSS Survey

- 10.1.5 In Low-Moderate Risk Zones/for Low-Moderate risk activities (see Paragraph 6.1.12), the risk posed by UXO can be mitigated by the avoidance of surface targets detected in MBES and SSS datasets where practicable.
- 10.1.6 This is applicable if only Low-Moderate risk activities are to be undertaken; if Moderate risk activities are also to be undertaken, UXO MAG Survey will be undertaken within that zone. Target deemed to be pUXO based upon MAG and MBES/SSS data would then need to be avoided.
- 10.1.7 For activities where the smallest UXO which presents a Low-Moderate risk is a depth charge, where practicable, all surface targets which are cylindrical or spherical and at least 0.7 m in length/diameter will be avoided.
- 10.1.8 For activities where the smallest UXO which presents a Low-Moderate risk is a contact mine, where practicable, all surface targets which are spherical or cylindrical and at least 1 m in length/diameter will be avoided.

UXO Magnetometer Survey

- 10.1.9 Table 10.1 details the detection requirements that should be used for UXO Surveys on the Proposed Development.

Table 10.1: Minimum Detection Requirements

Risk Zone	Minimum Threat Item	Ferrous Mass	Dimensions	Depth of Detection Below Seabed
C to F	Depth Charge	50 kg	0.7 m x 0.45 m	Up to 3 m

Magnetometer Survey Specification

- 10.1.10 The smallest threat item required to be reliably detected by the UXO Survey is a depth charge, with a ferrous mass of 50 kg.
- 10.1.11 Based on the above conditions, a magnetometer survey will be conducted using caesium vapour magnetometers (Geometrics G-882 or equivalent) with a sensor spacing of no more than 2 m between magnetometers (with an array and on reciprocal lines) and an altitude of no more than 4 m above the seabed. However, the above is provided as a minimum specification and the spacing between magnetometers should be reduced as much as is feasible to increase data quality, for example, 1.5 m spacing between magnetometers and an altitude of 2 m to 3 m. This additional data provides a better map of the seabed and a greater probability of detection, which ultimately assists in the interpretation of anomalies as potential UXO. It has been found that this greater data density will assist in reducing false anomalies and ultimately reducing the final number of targets that require further investigation/avoidance. In addition, starting with a greater data density often reduces the level of infill required, which can often take almost as long as the main survey.

Depth of Detection

- 10.1.12 As outlined in Paragraph 8.2.6, it was determined that the potential depth of munition burial could be to significant depths (>3 m below seabed) due to large-scale sandwaves present on site. It is not considered ALARP to survey for UXO to a depth greater than 3 m, and so the maximum required Depth of Detection is 3 m for the Proposed Development. Note, this would only be applicable where mobile sediment bedforms are shown to be present. Where mobile sediment bedforms are not present, a depth of detection of 2 m will be applied.

Additional Sensors

- 10.1.13 Where feasible high-frequency SSS (600 kHz+ survey with 200% coverage) and/or MBES (minimum 16 hits per metre) data will be collected to identify items that are currently situated on the surface or partially buried on the seabed. The high-resolution images that result from these surveys can be used to identify the location and shapes of the items. It should be noted that the SSS survey would only be able to identify larger items that remain at the surface of the seabed, not buried items.

10.2 Surrogate/Acceptance Trials

- 10.2.1 For the UXO survey, when using magnetic and/or sub-bottom imaging detection methods the survey contractor must design a trial to be carried out prior to the survey campaign in order to confirm the suitability of the equipment to be used. The trial will be carried out using the same equipment that will be used during the main survey operations.
- 10.2.2 The aims of the trials are to:
- demonstrate that all variants of pUXO that pose a threat to the site are detectable during the survey;
 - prove that the system has positional accuracy within specified tolerance by comparing to results of a separate positioning system. If available SSS and MBES should also be run over a surrogate item to verify equipment positioning; and
 - determine an appropriate detection range for the system to be used as a basis for coverage throughout the project.
- 10.2.3 In order to achieve this, the contractor will deploy and recover appropriate surrogate UXO items of known dimensions on a suitable area of seabed free from existing magnetic anomalies. The area needs to be free from ferrous objects to reduce the possibility of ferrous materials affecting the results of the trials.
- 10.2.4 The item(s) will then be surveyed with the equipment configuration which will be employed during the UXO survey. This would involve running survey lines at various heights to show the differing responses and detection limitations.
- 10.2.5 Based on the risk assessment carried out the following surrogate items will be used during survey trials within each zone (Table 10.2).

Table 10.2: Surrogate Item Specification

Risk Zone	Ordnance Simulant	Dimensions*		Ferrous Mass	Construction Material	Maximum Depth of Detection Below Seabed/Ground (m)
		Length (m)	Diameter (m)			
C to F	Depth charge	0.7	0.45	50	Steel	Up to 3 m

* The dimensions can differ from those listed here so long as the surrogate item is geophysically representative of the ordnance item.

10.3 Survey Corridor Requirements

- 10.3.1 The aim of a UXO survey is to provide a sufficiently wide corridor/area for cable/Wind Turbine installation activities to be undertaken. This corridor/area will be surveyed for UXO in line with the UXO survey specification, with subsequent investigation undertaken on any pUXO assessed as posing a risk to installation.
- 10.3.2 To do this an appropriate corridor width is defined around the route position list, within which all pUXO identified by the survey will be investigated and cleared. The corridor width will vary based on the survey accuracy and the installation techniques to be used during installation, including the area of potential impact of each installation methodology. Each anomaly that has been assigned pUXO must therefore be avoided by the distance calculated during installation activities.
- 10.3.3 A larger corridor will be surveyed to allow for re-routing around targets identified as pUXO. Generally speaking, an increased survey corridor allows more freedom in target avoidance/re-routing which leads to fewer pUXO targets requiring investigation. This typically results in significantly reduced overall costs. A typical survey corridor which allows for re-routing would be ~50 m.

10.4 Target Avoidance and Re-Routing

- 10.4.1 In order to allow safe re-routing of assets, it is essential to first define the required standoff distance to pUXO targets. This distance accounts for positional uncertainties in both survey data and installation methodologies to ensure that no items of pUXO are ever encountered during installation. Therefore, the standoff distance is dependent on a number of factors as described below:
- Installation Positional Accuracy – The accuracy with which the installation activity can take place. (e.g. the error in the positioning of the plough).
 - Half the Tool Footprint – Half the width of the tool (that interacts with the seafloor (i.e. half the width of a tracked trencher)).
 - UXO Survey Positional Accuracy – The positioning error in the data collected during the UXO survey. Typically, between 1 m and 2 m.
 - UXO Extent – Approximately equal to the length of the largest threat item, but based on the following:
 - Half the length of the maximum size of UXO – for this site, the largest threat items are torpedoes, with an approximate length of 7 m; and
 - Target picking error – based on error where the UXO Consultant/Geophysicist has picked the target location within the data. This depends on the size of the target (generally 1 m for smaller targets and 2 m for larger targets).

10.4.2 The calculation for the minimum standoff distance is given below:

$$\text{Standoff Distance} = \text{Installation positional accuracy} + \text{Half the Tool Footprint} + \text{UXO Survey positional Accuracy} + \text{UXO Extent}$$

Standoff Examples

10.4.3 The following shows typical examples of standoff distances used for each activity; however, these would need to be refined once the installation activity specifications are known. They are calculated in Table 10.3 and displayed in Figure 10.1.

Table 10.3: A Calculation of Example Standoff Distances

Examples	Installation Accuracy (m)	Half Tool Footprint (m)	Survey Accuracy (m)	UXO Extent (m)	Standoff Distance (m)
Ploughing	2	5	2	5.5	14.5*
Jetting	2	4	2	5.5	13.5*
Rock placement	2	3	2	5.5	12.5*
Dredging	2	1	2	5.5	10.5*

* Examples only and must be updated once installation accuracies, tool footprints and survey accuracies are known.

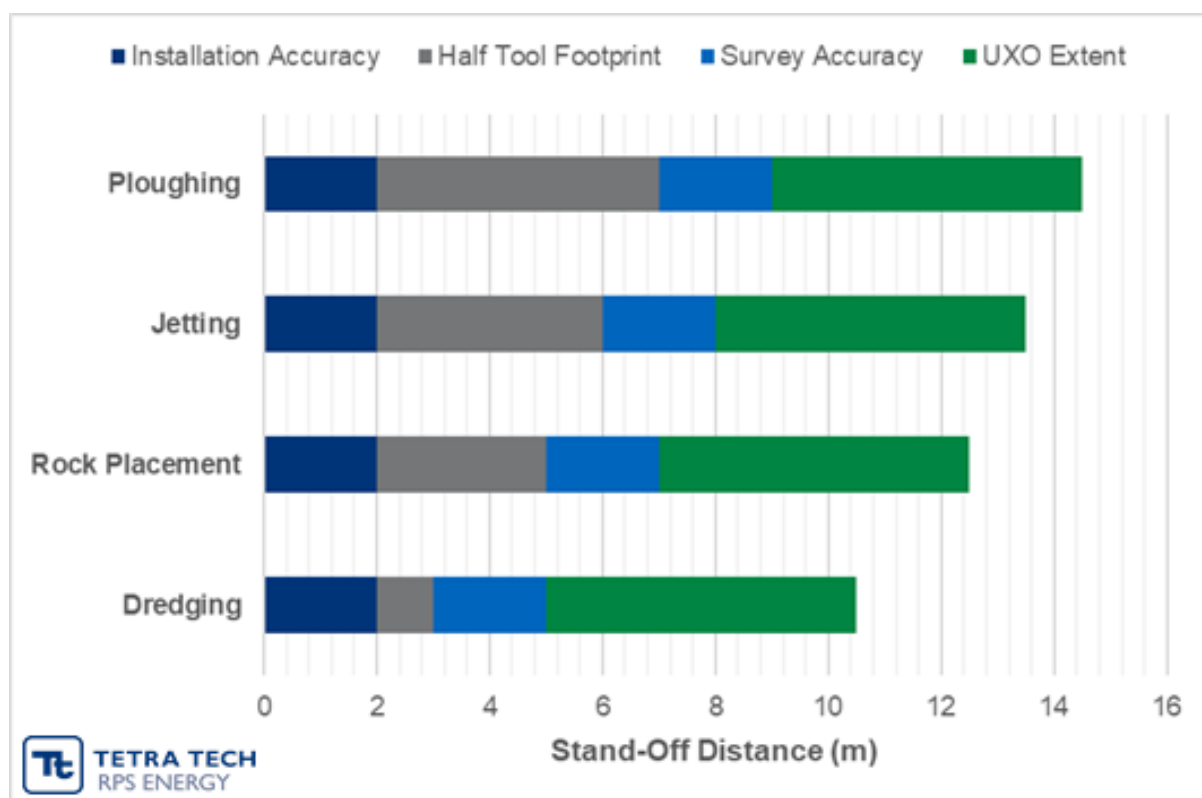


Figure 10.1: A Plot of Example Standoff Distances

Standoff Schematics

10.4.4 The following sections visualise the examples covered above; it is important to note that not all installation activities are covered. A further example can be found in Annex C.

Cable Installation

10.4.5 Figure 10.2 visualises the standoff distances required for cable installation.

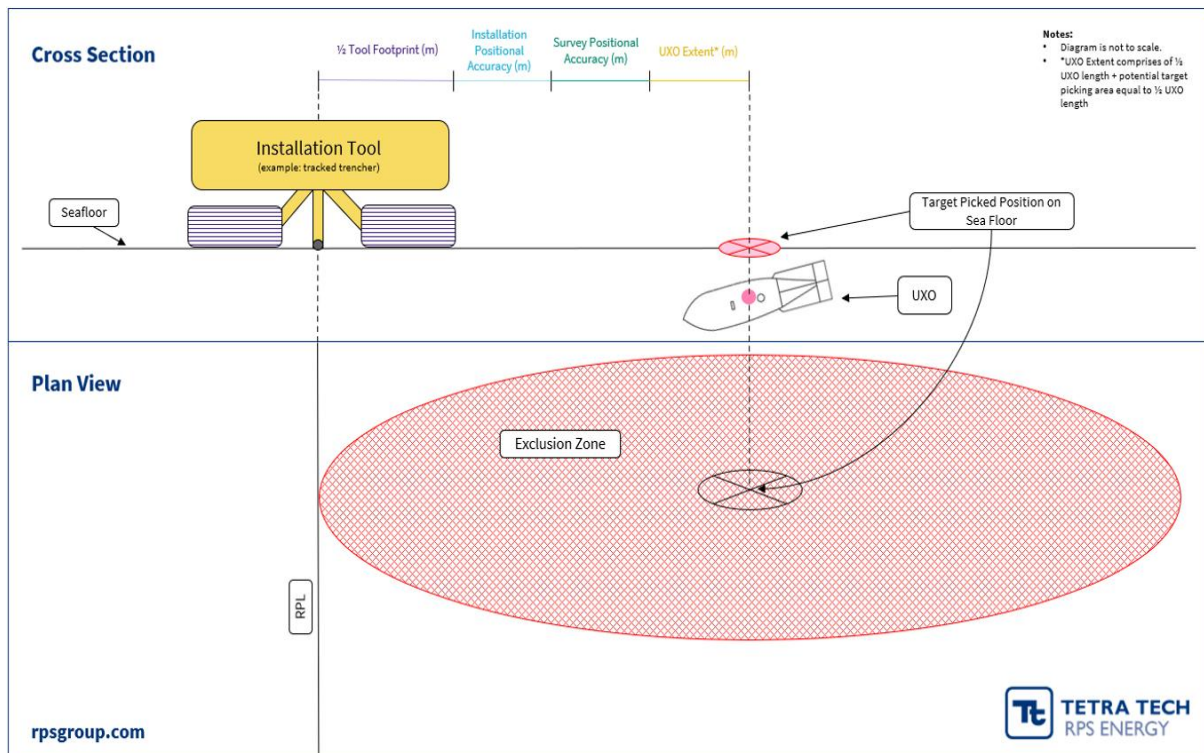


Figure 10.2: A Visualisation of the Standoff Distance Calculation for Cable Installation

Anchoring/Jack-Up Operations

10.4.6 Figure 10.3 visualises the standoff distances required for anchoring and jack-up operations. The exact distances for these activities will not be the same.

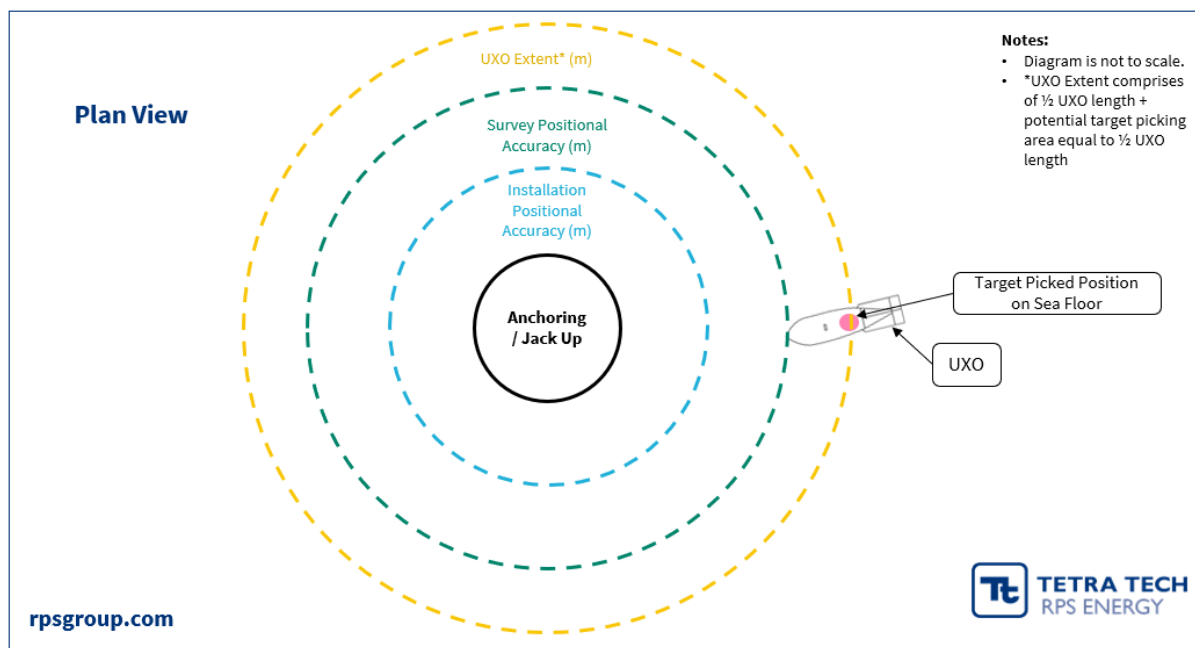


Figure 10.3: A Visualisation of the Standoff Distance Calculation for Anchoring/Jack-Up Operations

- 10.4.7 For anchoring, in addition to the radii, the contractor would need to include an additional safety buffer to allow for the positioning of their anchor and to cover any anchor drag along the seabed, as the anchor is pulled taught into the seabed.
- 10.4.8 It should be noted that the line/chain attached to the anchor is not considered a significant risk and therefore is not required to avoid anomalies by any specific distance.

Rock Placement

- 10.4.9 Figure 10.4 visualises the standoff distances required for rock placement.

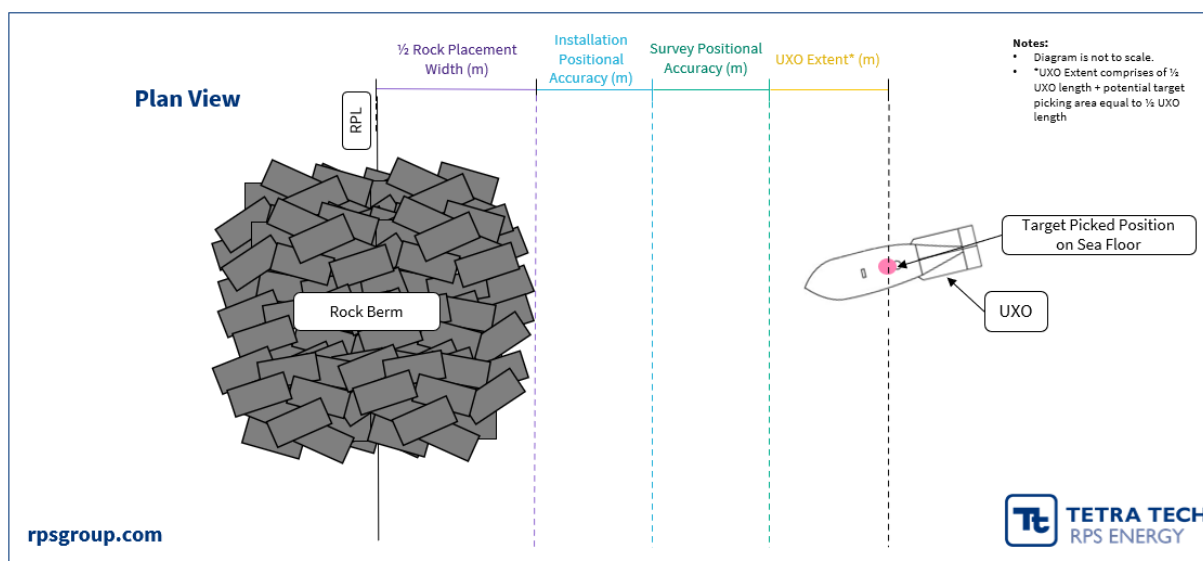


Figure 10.4: A Visualisation of the Standoff Distance Calculation for Rock Placement

10.5 Piling

- 10.5.1 With regards to piling activities, Section 6.1 shows that multiple munitions pose a Moderate risk. Studies have shown that sympathetic detonation of a UXO can occur some distance from the piling activities and is dependent on pile size, installation mechanism and soil conditions. Calculations can be conducted to determine this distance based on specific site conditions; however, in lieu of these calculations, a conservative estimate would be approximately 150 m.

11 Target Investigation

- 11.1.1 If avoidance is not possible or proves impractical, the target will be investigated to identify whether it is UXO and, if so, the item disposed of. Target investigation is generally conducted by deploying divers or Remotely Operated Vehicles (ROVs) or a combination of both. Consideration needs to be given as to whether the target is located on the surface or buried, and additionally to the visibility on site.
- 11.1.2 It is important to note that investigation of targets could be employed on targets not considered to be pUXO if they are considered to be items of debris which could cause complications to intrusive activities. However, the investigation techniques shall remain the same.
- 11.1.3 A database will be created following UXO Survey, where all targets and ID&C operations are recorded, will require significant attention. The target list is one of the primary deliverables of the UXO Survey, and significant attention must be given to professional database management, including quality assurance/quality control during all UXO Survey efforts.

11.2 Investigation by Remotely Operated Vehicle (ROV)

- 11.2.1 Work Class ROVs are considered a safe and practical way to investigate targets as they can be equipped with cameras, sonar and survey equipment for relocation and then with dredge pumps for excavation. They additionally keep personnel from physically contacting the UXO.
- 11.2.2 If ROVs are to be used, the following equipment/requirements should be met during any investigation, as a minimum:
- work class ROV;
 - capable of operating within the following conditions:
 - significant wave height min 2.5 m;
 - wind 12 m/s; and
 - 1.03 m/s current, fully laden (i.e. all equipment operating).
 - ROV High Definition (HD) camera system (two per ROV);
 - Inertial Navigation System (INS);
 - doppler velocity log;
 - digital edge HD recording system (or equivalent);
 - aris sonar (or equivalent);
 - adequate manipulators and grinders to conduct the required operations;
 - depth sensor accurate to +/- 1 m;
 - ability to carry out excursions at least 200 m from the vessel;
 - obstacle avoidance sonars;

- Ultra-Short Base Line (USBL) system, IXSea Gaps or equivalent;
- dredge pump capable of efficiently excavating sediments given the seabed conditions; and
- metal detector (e.g. innovatum/gradiometer (7 pin) or TSS pipe tracker (2 m array minimum)) for target relocation.

11.2.3 Optional:

- high-resolution sub-bottom imager.

11.2.4 The configuration of the camera system should allow for variations in view, strobe orientation and focal length in order to maximise data quality with respect to the prevailing conditions. A method of determining scale for the field of view should be evident in the video frame. The video should be supplied with its own source of illumination, which will be no less than 100 W (equivalent) and suitable to provide colour-balanced scene illumination at depth. The video shall be digitally recorded on board the vessel with a means to review, replay, capture and extract data digitally immediately after acquisition.

11.2.5 The TSS 440 or Innovatum system shall be calibrated with a metal test piece (or small surrogate item) at the beginning of the project as a minimum but preferably prior to each dive.

11.2.6 Given the time and cost implications of the ID&C operations the importance of efficient, capable dredging, handling and visual inspection instruments for the ID&C operations are to be underlined explicitly. Only with a significant dredging capacity to expose buried targets in as little time as possible and with manipulators and sensors which enable the ID&C ROV to work efficiently and effectively, cost per target can be reduced. Removal of non-UXO targets away from the cable route to avoid obstruction to cable installation at a later stage is required simultaneously to reduce overall project costs. An ROV capable of both efficient and effective identification of targets and efficient and effective clearance of debris is therefore recommended.

11.3 Investigation by Diver

11.3.1 If there is poor visibility, Explosive Ordnance Disposal (EOD) trained divers are more often used for investigation. The advantage of using divers in this environment is that they can perform a tactile investigation where the visibility would prevent a positive identification being conducted visually. The divers would use handheld locators (metal detectors) to find the target and diver-operated air lifts to expose buried objects. However, if targets are buried deeply (i.e. more than ~1 m) then it may be preferable to use remote operated excavation equipment due to the safety implications of diving near excavations and the risk of hole collapse.

11.3.2 If divers are to be used, the following equipment to be deployed during the investigations as a minimum:

- divers must have UXO familiarisation and search training/experience;

- surface supplied diving (as opposed to Self-Contained Underwater Breathing Apparatus (SCUBA)). If SCUBA is proposed, justification for this method should be provided;
- diver to surface communications;
- diver to vessel live and recordable video link, via the diver's helmet;
- diver held metal detectors capable of detecting to 2 m below seabed (DX200 or better);
- Digital Edge HD recording system (or equivalent);
- USBL system (IXSea Gaps or better); and
- handheld sonars (optional, if available).

11.3.3 A method of determining scale for the field of view should be evident in the video frame. The video should be supplied with its own source of illumination, which will be no less than 100 W (equivalent) and suitable to provide colour-balanced scene illumination at depth. The video shall be digitally recorded on board the vessel with a means to review, replay, capture and extract data digitally immediately after acquisition.

11.4 Confirmed UXO

- 11.4.1 If a target is positively identified as UXO, an assessment of the likelihood of the object moving prior to installation activities would need to be made to determine whether it can be avoided or whether it would need to be disposed of.
- 11.4.2 If the confirmed UXO requires disposal, it would be dealt with by the investigation contractor. As such, consideration needs to be given with regards to the permits and licenses to be held by the UXO contractor undertaking the works.
- 11.4.3 Under the Marine and Coastal Access Act 2009, any activity that may affect the marine environment, including UXO disposal, requires a marine licence; within Scottish waters this is issued by the Marine Directorate.
- 11.4.4 Marine environment: unexploded ordnance clearance Joint Position Statement (HM Government, 2025) states that low noise methods of clearance should be the default method for clearing UXO in the marine environment, unless extraordinary circumstances mean low noise clearance cannot be undertaken. High order clearance should always be the method of last resort.
- 11.4.5 Alternatively, if the UXO is not disposed of then it will need to be avoided. The avoidance distance should obviously be as large as possible; however, as a minimum, the avoidance distance (i.e. the distance at which the activities must be from the confirmed UXO) is calculated in the same manner as the survey corridor width/avoidance distance (Paragraph 10.4).

12 ALARP Sign-Off

- 12.1.1 Based on the outcome of the UXO Survey and subsequent avoidance and/or investigation activities, ALARP sign-off would be provided for the site, which would demonstrate that appropriate mitigation has been implemented in order to reduce the risks from UXO to installation activities to an acceptable level (i.e. ALARP).
- 12.1.2 Based on the anticipated site conditions across the Proposed Development, it is anticipated there to be at least some level of burial of UXO due to scour and sediment deposition.
- 12.1.3 The probability of an item of UXO migrating along the seabed due to water flow (tidal stream/current) is a function, among others, of seabed composition, firmness and morphology (slopes, ripples, troughs, boulders etc.); the current strength, duration and persistence of direction; and the weight, shape and orientation of the UXO. As outlined in the Volume 2, Chapter 7: Physical Processes baseline assessment, the currents flowing through a project site will vary with location but is generally greater closer inshore. As such, offshore it is unlikely that UXO will move due to normal tidal currents within the project areas (Section 8.1).
- 12.1.4 In terms of wave action moving UXO in deeper waters (>10 m Lowest Astronomical Tide (LAT)), it is considered unlikely and would require extraordinary conditions for the UXO to moved such as significant storm events.
- 12.1.5 Therefore, based on anticipated site conditions and barring unknown factors, for example fishing trawling bringing UXO on to site, mobility should be limited. As such, in the offshore (>-10 m water depth), an **ALARP validity of five years from the date of the mitigation/survey taking place** would be expected. However, the site conditions would need to be continually monitored and periodically reviewed to ensure this validity and to potentially carry it past the five-year period.
- 12.1.6 In the nearshore (<-10 m water depth), an **ALARP validity of two years from the date of the mitigation/survey taking place** would be expected. However, the site conditions would need to be continually monitored and periodically reviewed to ensure this validity and to potentially carry it past the two-year period.
- 12.1.7 This sign-off would advise whether residual risk mitigation is required, which would be finalised after the mitigation is completed. However, the likely possible requirements are detailed in the following sections.

12.2 Data Review

- 12.2.1 To determine where it is possible to continue/extend the validity of the ALARP, the area will be reassessed given any recently available survey data (SSS/MBES etc.), and if required propose discrete survey of pertinent targets, areas with potential for new targets and/or in areas of sediment mobility to re-validate the findings. Changes which may prevent or limit the area of an extension to the ALARP or would include:
- new targets identified which may have been brought in from outside the survey area via tidal currents/wave action;
 - known targets migrating within the survey area, indicating target migration as above; and
 - significant changes in sediment mobility, such as:
 - large-scale mobile bedforms migrating significantly; and
 - net erosion in the area.
- 12.2.2 In addition to the above, any changes in industry practices would be reviewed to align the ALARP process in the future. This review can be undertaken at any stage prior to the expiry of the certification (for example at 1.5/4.5 years) in order to allow uninterrupted continuation of projects beyond the expiry date.

13 Tertiary Mitigation

- 13.1.1 The following section outlines in more detail the recommended methods of tertiary mitigation that can be implemented on site to further reduce the risks associated with UXO encounters. Table 9.1 details the zones/activities where tertiary mitigation is recommended in place of primary mitigation.
- 13.1.2 However, even where a Low risk has been assessed or after primary mitigation measures are implemented there will always remain a residual possibility that UXO could be encountered or potentially brought on board the vessels working in the area. Due to the residual risk, it is therefore recommended that as a minimum explosives safety awareness be implemented to manage any inadvertent UXO encounters during operations and maintenance.

13.2 Explosives Safety Awareness

- 13.2.1 Explosives safety and awareness briefings will be provided to personnel carrying out operations and maintenance works. The briefing will allow the project team to plan the proposed works and potentially deal with the event of a suspicious item/UXO discovery incident. It would address the risk to all of the specific proposed works and will inform personnel how to undertake the works safely and will refer to the specific risk items/hazards that have been identified for the site and where applicable the mitigation that has been completed to reduce the risk.
- 13.2.2 If deemed beneficial, a set of explosives site safety guidelines will be produced, which would be provided along with training. The guidelines would allow the project team to manage the Safety and Awareness Briefings and provide them in-house and also allow the project team to manage an inadvertent UXO encounter. The guidelines would typically be provided to the Applicant in the form of a 'Guidelines Document' along with a supporting PowerPoint slideshow. Safety and awareness training would be provided to key personnel, offshore teams, survey and trenching teams.
- 13.2.3 It is specifically recommended that these be delivered to personnel involved in intrusive works on the seabed. Training on how to recognise UXO for these personnel would be considered most prudent given the risks in the area.

13.3 Explosives Engineer on Vessel

- 13.3.1 In areas where a proactive survey and avoidance strategy is not practicable, for example in areas where survey data was inconclusive, Explosives Safety Engineers (EOD trained) will be based on board the vessel(s) during operations, in order to reduce the risks to personnel and equipment and avoid unnecessary delays and associated costs.
- 13.3.2 Importantly, this method should not replace any survey and should only be used where survey was not possible.
- 13.3.3 Not all apparent UXO items contain energetic material. A qualified Explosives Safety Engineer can often determine which items are considered UXO and deal with them accordingly. In some cases, it may not be possible to visually

determine what the item is due to corrosion or encrustation and therefore whether it is UXO or something benign, such as an oil drum. The EOD Engineer would therefore be able to carry out ordnance recognition and minimise delays due to items that do not turn out to be UXO.

13.3.4 The EOD support would include but not be limited to:

- attendance at risk assessment meetings, such as Hazard Identification and Risk Assessments (HIRAs);
- carrying out Explosive Ordnance Safety and Awareness Briefings for all personnel. The Briefings would be given to all operational personnel working for the Applicant on site during cable lay operations;
- development of Emergency Response Plans;
- monitoring works in order to identify potential UXO items if they are uncovered as works progress;
- inspecting the equipment (grapnel and trenching equipment) when it is brought back on board the vessel to ensure no ordnance are brought back on board;
- assist in liaison with relevant authorities/personnel should ordnance be identified and present an explosive hazard;
- where it is not practical or safe to observe the intrusive works, the Explosives Safety Engineer will be on-call and immediately available to respond to a request for assistance;
- provide on-call services to immediately respond to suspected ordnance that has been discovered by other site staff; and
- identify an area to which safe-to-move ordnance may be stored prior to recovery by the appropriate authorities.

13.3.5 The main aim would be to avoid interaction with UXO and consider the mitigation that will have already been undertaken in Moderate risk areas and therefore the resulting reduced risk, the risk of encounter should be low. However, should an item of ordnance be discovered then the following action will be taken:

- If an item is identified as ordnance, the Explosives Safety Engineer will carry out an ordnance risk assessment. They will assess the nature of the item, its initiation system as well as determining the explosive content. They will assess the requirement and size of any exclusion zone around the item.
- The Explosives Safety Engineer will inform the Applicant as to the nature of the item and the conclusions of the risk assessment.
- If the item does not contain any hazardous components, the Explosives Safety Engineer may remove it from the area of works, or if on the seafloor inform the Applicant that works can continue.

- If the item is deemed to pose a risk and cannot be moved, the Explosives Safety Engineer will contact the relevant authorities to dispose of the item.

13.4 Explosives Engineer On-Call for Offshore Activities

- 13.4.1 If an Explosive Engineer on Vessel is not deemed necessary, an on-call service will be set up which can be used by the contractors in the event of a potential UXO encounter. This would provide 24/7 on-call availability to a UXO Expert who could assist the vessel in dealing with a potential UXO encounter. A procedure would be implemented in the event that potential UXO is encountered during installation so that the item can be identified and dealt with as quickly as possible.

13.5 Anchor Management

- 13.5.1 Typically, anchor deployment is carried out by dynamically positioned vessels. In offshore construction, typical anchors include delta flipper types, which are employed for lateral positioning. A delta flipper type anchor will only embed if it arrives on the seabed in the correct orientation, therefore, a second line must be used to ensure correct orientation. The process is as follows:
- the anchor is lowered from the vessel;
 - a second vessel is used to ensure the anchor deploys at a shallow angle; this cable is kept taught to maintain the angle of lowering; and
 - the anchor contacts the seabed, no further pulling is required.
- 13.5.2 Additionally, anchors connected to a steel wire rope mooring line will penetrate deeper than an anchor connected to a chain mooring line. It should be noted that the line/chain attached to any anchor is not considered a significant risk. The highest risk involved with anchoring and encountering UXO is associated with the anchor directly striking a UXO with sufficient force to cause a detonation. Any tensioning once the anchor is placed is expected to have insufficient energy to cause a detonation.
- 13.5.3 As such, in order to mitigate the risk from UXO during anchoring activities, it is recommended that a controlled anchor lowering takes place to reduce the potential force exerted on any items of UXO.

14 Summary

14.1 UXO Risk Level

- 14.1.1 Based on the conclusions of the research and the risk assessment undertaken, a varying **Low-Moderate** and **Moderate** risk from encountering UXO has been identified within the UXO Study Area. The risk is primarily due to the potential presence of projectiles, HE bombs, sea mines, torpedoes and depth charges.
- 14.1.2 The category of UXO is also taken into account both when assessing the probability of the item functioning and the consequence of such an event. This leads to the varying risk levels between munitions with the same installation methodology. The full risk matrices are presented in Annex A providing an assessment of the risk associated with each activity.
- 14.1.3 The Proposed Development has been split into 6 zones (A to F), dependent on the risk presented and the planned installation activities.
- 14.1.4 Table 14.1 shows the maximum risk for each zone.

Table 14.1: Overall Risk Level

Overall Risk Level							
UXO		Risk Zone					
		A	B	C	D	E	F
Small arms ammunition		Low	Low	Low	Low	Low	Low
Land service ammunition		Low	Low	Low	Low	Low	Low
≤155 mm projectile		Low	Low	Low	Low	Low	Low
>155 mm projectile		Low	Low	Low	Low	Low	Low
HE bombs	Allied origin	Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
	German origin	Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
Sea Mines	Allied origin – contact mines	Low-Mod	Low-Mod	Mod	Mod	Mod	Mod
	Allied origin – ground mines	Low	Low	Mod	Mod	Mod	Mod
	German origin – contact mines	Low-Mod	Low-Mod	Low-Mod	Low	Low	Mod
	German origin – ground mines	Low	Low	Low	Low	Low	Low
Land mines		Low	Low	Low	Low	Low	Low
Torpedoes		Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
Depth charges		Low-Mod	Low	Mod	Mod	Mod	Mod

Overall Risk Level						
Dumped conventional munitions	Low-Mod	Low	Low	Low	Low-Mod	Low-Mod
Dumped chemical munitions	Low	Low	Low	Low	Low	Low
Missiles/rockets	Low	Low	Low	Low	Low	Low

14.2 Burial

- 14.2.1 In the softer sediments, it is possible for munitions to be covered by shifting sediments on the seabed and subsequently become buried. This is dependent on the mass, dimensions/shape of the item and the sediments upon which it came to rest as well as the currents affecting the area, however, the maximum burial depth due to scour is approximately equal to the diameter of the munition. Burial is not possible in areas where bedrock is exposed.
- 14.2.2 For the majority of the Proposed Development, burial via natural processes will be the primary mechanism of burial. Where mobile sediment bedforms are not present, the depth of burial is likely to be limited to scour depth (approximately equal to the diameter of the munition). Where mobile sediment bedforms are present, munition burial could be increased by up to the maximum height of the bedform.

14.3 Mitigation

- 14.3.1 Based on the identified risk levels, appropriate mitigation must be implemented to reduce the risk, prior to and/or during any works.
- 14.3.2 The methods of mitigation outlined for the site, which consist of both Primary and Tertiary methodologies, will allow the project team to design an appropriate strategy to mitigate the risks.
- 14.3.3 For all risk areas and activities, all personnel must be provided an explosives safety and awareness briefing as a minimum.

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ANNEX A. RISK ASSESSMENT

	Activity / Pathway																	
	Cable Lay	Ploughing	Vessel Mounted Jetting	Tracked Vehicle Jetting	Chain Cutter	Snag on Vessel	Dredging	Backhoe Excavation	MFE	HDD	Anchoring	Jack-Up Operations	Piled Foundations	Suction Pile Foundations	Rock Placement	Mattress Installation	Peel Grab Operations	Boulder Plough
Regular Munitions	Probability of Detonation																	
Small Arms Ammunition	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Land Service Ammunition	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
≤155mm Projectiles	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
>155mm Projectiles	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
HE Bombs	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Axis Origin	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Allied Origin - Contact Mines	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Allied Origin - Ground Mines	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Axis Origin - Contact Mines	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Axis Origin - Ground Mines	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Land Mines	F	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Torpedoes	D	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Depth Charges	D	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Conventional Dumped Munitions	E	D	F	D	C	C	D	D	D	D	D	D	D	D	D	D	D	D
Dumped Chemical Munitions	E	D	F	D	C	C	D	D	D	D	D	D	D	D	D	D	D	D
Missiles/Rockets	E	D	F	D	C	C	D	D	D	D	D	D	D	D	D	D	D	D

Source: UXO
Potential Pathway: WTG Installation and Cable Lay Operations
Potential Receptor: People, Equipment, Infrastructure, Vessels, Environment

Probability: A = High probability to F = Low probability
Consequence: 1 = High to 5 = Low

Assumptions: Probability of detonation is based on an encountering a single item
Consequence/Impact levels are based on the worst case consequence/impact for each tier level

Activity / Pathway																							
Cable Lay	Ploughing	Vessel Mounted Jetting	Tracked Vehicle Jetting	Chain Cutter	Snag on Vessel	Dredging	Backhoe Dredger	MFE	HDD	Anchoring	Jack-Up Operation	Piled Foundations	Suction Pile Foundations	Rock Placement	Mattress Installation	Peel Grab Ops	Boulder Plough	PLGR	Borehole/Vibrocore	CPT	Grab Sampling		
Water Depth																							
0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m	0m-10m	>10m
Consequence of Detonation																							
0m-10m	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
10m-20m	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
20m-30m	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
30m-40m	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40m-50m	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
50m-60m	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
60m-70m	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
70m-80m	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
80m-90m	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
90m-100m	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
100m-110m	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
110m-120m	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
120m-130m	13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
130m-140m	14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
140m-150m	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
150m-160m	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
160m-170m	17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
170m-180m	18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
180m-190m	19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
190m-200m	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Area	Approx. Depth Range (m LAT)	UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway																								
					Cable Lay	Risk Rating	Ploughing	Risk Rating	Vessel Mounted Jetting	Risk Rating	Tracked Vehicle Jetting	Risk Rating	Chain Cutter	Risk Rating	Snag on Vessel*	Risk Rating	Dredging	Risk Rating	Backhoe Dredger	Risk Rating	MFE	Risk Rating	HDD	Risk Rating					
Zone A	<10m					Final Hazard Level																							
		Regular Munitions	D	E	DF5	Negligible	DE5	Low	DE5	Low	DD5	Low	DE5	Low	EE3	Low	DE5	Low	DE5	Low	DE5	Low	DE5	Low	DE5	Low	DE5	Low	
		Small Arms Ammunition	D	E	DE5	Low	DD5	Low	DE5	Low	DD5	Low	DD5	Low	ED2	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	
		Land Service Ammunition	D	E	DF5	Negligible	DD5	Low	DD5	Low	DD5	Negligible	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	
		>155mm Projectiles	D	E	DF4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	ED2	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	
		>155mm Projectiles	D	E	DD3	Low	DD3	Low	DD2	Low	DD3	Low	DD3	Low	EC2	Low	DD2	Low-Mod	DD2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	
		HE Bombs	D	E	DF3	Low	DD3	Low	DD2	Low-Mod	DF3	Low	DD3	Low-Mod	EC2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	
		Axis Origin	D	E	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	EB2	Low*	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	
		Allied Origin - Contact Mines	E	F	EF2	Low	ED2	Low	EC2	Low	EE2	Low	EB2	Low	FD2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	
		Allied Origin - Ground Mines	D	E	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	EB2	Low*	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	
		Axis Origin - Contact Mines	D	E	EF2	Low	ED2	Low	EC2	Low	EE2	Low	EB2	Low	FD2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	ED2	Low	
		Axis Origin - Ground Mines	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	ED2	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	
		Land Mines	D	E	DD2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low-Mod	EC2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	
		Torpedoes	D	E	DD2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	EC2	Low	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	
		Depth Charges	D	E	DD2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	EC2	Low	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low-Mod	
		Conventional Dumped Munitions	D	E	DE2	Low	DD2	Low	DE2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	
		Dumped Chemical Munitions	E	F	EE4	Low	ED4	Low	EE4	Low	ED4	Low	ED4	Low	FD2	Low	ED4	Low	ED4	Low	ED4	Low	ED4	Low	ED4	Low	ED4	Low	
		Missiles/Rockets	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DD3	Low	ED2	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	

					Activity / Pathway																									
UXO					Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Anchoring	Risk Rating	Jack-Up Operation	Risk Rating	Rock Placement	Risk Rating	Matress Installation	Risk Rating	Peel Grab Operations	Risk Rating	Boulder Plough	Risk Rating	PLGR	Risk Rating	Borshole/Vibrocore	Risk Rating	CPT	Risk Rating	Grab Sampling	Risk Rating				
Regular Munitions					D	E	Final Hazard Level																							
Small Arms Ammunition					D	E	DFS	Negligible	DFS	Negligible	DE5	Low	DFS	Negligible	DFS	Negligible	DE5	Low	DFS	Negligible	DFS	Negligible	DFS	Negligible	DFS	Negligible	DFS	Negligible		
Land Service Ammunition					D	E	DE5	Low	DE5	Low	DD5	Low	DE5	Low	DE5	Low	DD5	Low	DE5	Low	DE5	Negligible	DE5	Negligible	DE5	Negligible	DE5	Negligible		
>155mm Projectiles					D	E	DD5	Low	DD5	Low	DE5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5	Negligible	DD5	Negligible	DD5	Negligible	DD5	Negligible		
>155mm Projectiles					D	E	DD4	Low	DD4	Low	DE4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low		
		HE Bombs	D	E	DD3	Low	DD2	Low	DD2	Low	DE2	Low	DE2	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED2	Low	ED2	Low	ED2	Low		
		Axis Origin	D	E	DE3	Low	DE2	Low	DE2	Low	DE2	Low	DE2	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED2	Low	ED2	Low	ED2	Low		
		Axis Origin - Contact Mines	D	E	DD2	Low-Mod	DD2	Low-Mod	DE2	Low-Mod	DD2	Low	DD2	Low	DD2	Low-Mod	DE2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Allied Origin - Contact Mines	D	E	DD2	Low-Mod	DD2	Low-Mod	DE2	Low-Mod	DD2	Low	DD2	Low	DD2	Low-Mod	DE2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Allied Origin - Ground Mines	D	E	DD2	Low	DD2	Low-Mod	DE2	Low-Mod	DD2	Low	DD2	Low	DD2	Low-Mod	DE2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Axis Origin - Contact Mines	D	E	DD2	Low-Mod	DD2	Low-Mod	DE2	Low-Mod	DD2	Low	DD2	Low	DD2	Low-Mod	DE2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Axis Origin - Ground Mines	D	E	DD4	Low	DD4	Low	DE4	Low	DE4	Low	DE4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low		
		Land Mines	D	E	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Torpedoes	D	E	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Depth Charges	D	E	DD2	Low-Mod	DD2	Low-Mod	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low-Mod	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Conventional Dumped Munitions	D	E	DE2	Low	DE2	Low	DD2	Low	DE2	Low	DE2	Low	DE2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low	DD2	Low		
		Dumped Chemical Munitions	E	F	EE4	Low	EE4	Low	ED4	Low	ED4	Low	EE4	Low	ED4	Low	ED4	Low	ED4	Low	ED4	Negligible	FE4	Negligible	FE4	Negligible	FE4	Negligible		
		Missiles/Rockets	D	E	DE3	Low	DE3	Low	DD3	Low	DD3	Low	DE3	Low	DE3	Low	DD4	Low	EE3	Low	EE3	Low	EE3	Low	EE3	Low	EE3	Low		

Probability: A = high probability to F = Low probability
Consequence: 1 = High to 5 = Low

Final Hazard Level: Encounter (Detonation - Consequence)

Risk Levels:	High
	Moderate
	Low-Moderate
	Low
	Negligible

Notes: For 'Hazard Levels on Seabed' the depth is stated at the top left of this page
For 'Hazard Levels on Vessel' the depth is Surface (0 m)
All Hazard Levels given are prior to any mitigation
(Detonation - Consequence) Levels are taken from worksheet Hazard_Eval-1
Snag on Vessel refers to any possibility of snagging UXO and transferring to vessel
The final risk rating is based on the highest score for each activity
* Low Risk based on low Probability of Encounter despite high Probability and Consequence of Detonation
* For encounter of Chemical Munitions on vessel, the likelihood of snag on vessel resulting from retrieval of cable is considered to be minimal but this does not include residues contaminating equipment

Area	Approx. Depth Range (m LAT)	UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway																			
Zone B	>10m				Cable Lay	Risk Rating	Ploughing	Risk Rating	Vessel Mounted Jetting	Risk Rating	Tracked Vehicle Jetting	Risk Rating	Chain Cutter	Risk Rating	Snag on Vessel*	Risk Rating	Dredging	Risk Rating	MFE	Risk Rating	Anchoring			
Regular Munitions					Final Hazard Level																			
HE Bombs	Sea Mines	Small Arms Ammunition	E	F	EF5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	FE3	Low	EE5	Negligible	EE5	Negligible	EF5			
		Land Service Ammunition	E	F	EE5	Negligible	ED5	Low	EE5	Negligible	ED5	Low	ED5	Low	ED5	Low	ED5	Low	ED5	Low	EE5			
		≤155mm Projectiles	D	E	DF5	Negligible	DD5	Low	DD5	Low	DF5	Negligible	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5			
		>155mm Projectiles	D	E	DF5	Negligible	DD5	Low	DD5	Low	DF5	Negligible	DD5	Low	DD5	Low	DD5	Low	DD5	Low	DD5			
		Allied Origin	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4			
		Axis Origin	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4			
		Allied Origin - Contact Mines	D	E	DD3	Low	DD3	Low-Mod	DD3	Low-Mod	DD3	Low-Mod	DD3	Low-Mod	EB2	Low*	DD3	Low-Mod	DD3	Low	DD3			
		Axis Origin - Contact Mines	D	E	DD3	Low	DD3	Low-Mod	DD3	Low-Mod	DD3	Low-Mod	DD3	Low-Mod	EB2	Low*	DD3	Low-Mod	DD3	Low	DD3			
		Allied Origin - Ground Mines	E	F	EF3	Low	ED3	Low	EC3	Low	EE3	Low	EB3	Low	FD2	Low	ED3	Low	EF3	Low	EE3			
		Axis Origin - Ground Mines	D	E	DB3	Low-Mod	DB3	Low-Mod	DB3	Low-Mod	DB3	Low-Mod	DB3	Low-Mod	EB2	Low*	DB3	Low-Mod	DB3	Low-Mod	DB3			
Sea Mines	Sea Mines	Axis Origin - Ground Mines	E	F	EF3	Low	ED3	Low	EC3	Low	EE3	Low	EB3	Low	FD2	Low	ED3	Low	EF3	Low	EE3			
		Land Mines	E	F	ED5	Negligible	ED5	Low	ED5	Negligible	ED5	Low	ED5	Low	ED5	Low	ED5	Low	ED5	Low	ED5			
		Torpedoes	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3			
		Depth Charges	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3			
		Conventional Dumped Munitions	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DD3	Low	ED2	Low	DD3	Low	DD3	Low	DE3			
		Dumped Chemical Munitions	E	F	EE4	Low	ED4	Low	EE4	Low	ED4	Low	EC4	Low	FD2	Low	ED4	Low	ED4	Low	EE4			
		Missiles/Rockets	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DD3	Low	ED2	Low	DD3	Low	DD3	Low	DE3			
		Regular Munitions					Final Hazard Level																	
		HE Bombs	Sea Mines	Small Arms Ammunition	E	F	EE5	Negligible	EF5	Negligible	EF5	Negligible	EE5	Negligible	EE5	Negligible	FF5	Negligible	FF5	Negligible	FF5	Negligible	FF5	
				Land Service Ammunition	E	F	ED5	Low	EE5	Negligible	EE5	Negligible	ED5	Low	ED5	Low	FE5	Negligible	FE5	Negligible	FE5	Negligible	FE5	
≤155mm Projectiles	D			E	DE5	Low	DE5	Low	DE5	Low	DD5	Low	DD5	Low	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5			
>155mm Projectiles	D			E	DE5	Low	DE5	Low	DE5	Low	DD5	Low	DD5	Low	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5			
Allied Origin	D			E	DD4	Low	DE4	Low	DE4	Low	DD4	Low	DD4	Low	ED4	Low	ED4	Low	EE4	Low	EE4			
Axis Origin	D			E	DD4	Low	DE4	Low	DE4	Low	DD4	Low	DD4	Low	ED4	Low	ED4	Low	EE4	Low	EE4			
Allied Origin - Contact Mines	D			E	DD3	Low-Mod	DD3	Low	DD3	Low	DD3	Low-Mod	DD3	Low-Mod	EB2	Low	DD3	Low	DD3	Low	DD3			
Axis Origin - Contact Mines	D			E	DD3	Low-Mod	DD3	Low	DD3	Low	DD3	Low-Mod	DD3	Low-Mod	EB2	Low	DD3	Low	DD3	Low	DD3			
Allied Origin - Ground Mines	E			F	EE3	Low	EE3	Low	EE3	Low	ED3	Low	ED3	Low	FE3	Low	FE3	Low	FE3	Low	FE3			
Axis Origin - Ground Mines	D			E	DB3	Low-Mod	DD3	Low	DD3	Low	DB3	Low-Mod	DB3	Low-Mod	EB3	Low	ED3	Low	ED3	Low	ED3			
Sea Mines	Sea Mines	Axis Origin - Ground Mines	E	F	EF3	Low	ED3	Low	ED3	Low	ED3	Low	ED3	Low	FD3	Low	FD3	Low	FD3	Low	FD3			
		Land Mines	E	F	EE5	Negligible	EE5	Negligible	EE5	Negligible	ED5	Low	ED5	Low	FE5	Negligible	FE5	Negligible	FE5	Negligible	FE5			
		Torpedoes	D	E	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD3	Low	ED3	Low	ED3	Low	EE3	Low	EE3			
		Depth Charges	D	E	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD3	Low	ED3	Low	ED3	Low	EE3	Low	EE3			
		Conventional Dumped Munitions	D	E	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD3	Low	ED3	Low	ED3	Low	EE3	Low	EE3			
		Dumped Chemical Munitions	E	F	ED4	Low	EE4	Low	EE4	Low	ED4	Low	ED4	Low	FE4	Negligible	FE4	Negligible	FE4	Negligible	FE4			
		Missiles/Rockets	D	E	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD4	Low	EE3	Low	EE3	Low	EE3	Low	EE3			

Probability: A = high probability to F = Low probability
Consequence: 1 = High to 5 = Low

Final Hazard Level: Encounter (Detonation - Consequence)

Risk Levels:

High
Moderate
Low-Moderate
Low
Negligible

Notes: For 'Hazard Levels on Seabed' the depth is stated at the top left of this page
For 'Hazard Levels on Vessel' the depth is Surface (0 m)
All Hazard Levels given are prior to any mitigation
(Detonation - Consequence) Levels are taken from worksheet Hazard_Eval-1
Snag on Vessel refers to any possibility of snagging UXO and transferring to vessel
The final risk rating is based on the highest score for each activity
* Low Risk based on low Probability of Encounter despite high Probability and Consequence of Detonation
* For encounter of Chemical Munitions on vessel, the likelihood of snag on vessel resulting from retrieval of cable is considered to be minimal but this does not include residues contaminating equipment

Area	Approx. Depth Range (m LAT)	UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway																
Zone C	>10m				Cable Lay	Risk Rating	Ploughing	Risk Rating	Vessel Mounted Jetting	Risk Rating	Tracked Vehicle Jetting	Risk Rating	Chain Cutter	Risk Rating	Snag on Vessel*	Risk Rating	Dredging	Risk Rating	MFE	Risk Rating	Anchoring
Regular Munitions					Final Hazard Level																
		Small Arms Ammunition	E	F	EF5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	FE3	Low	EE5	Negligible	EE5	Negligible	EF5
		Land Service Ammunition	E	F	EE5	Negligible	ED5	Low	EE5	Negligible	ED5	Low	ED5	Low	FD2	Low	ED5	Low	ED5	Low	EE5
		<155mm Projectiles	D	E	DF5	Negligible	DD5	Low	DD5	Low	DF5	Negligible	DD5	Low	ED2	Low	DD5	Low	DD5	Low	DD5
		>155mm Projectiles	D	E	DF5	Negligible	DD5	Low	DD5	Low	DF5	Negligible	DD5	Low	ED2	Low	DD5	Low	DD5	Low	DD5
		HE Bombs	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	EC2	Low	DD4	Low	DD4	Low	DD4
		Axis Origin	D	E	DF4	Low	DD4	Low	DD4	Low	DF4	Low	DD4	Low	EC2	Low	DD4	Low	DD4	Low	DD4
		Axis Origin - Contact Mines	C	D	CC3	Mod	CB3	Mod	CB3	Mod	CC3	Mod	CB3	Mod	DB2	Low-Mod	CB3	Mod	CC3	Mod	CB3
		Axis Origin - Ground Mines	C	D	CF3	Low	CD3	Low	CC3	Mod	CF3	Low	CD3	Low	DD2	Low	CD3	Low	CF3	Low	CD3
		Axis Origin - Contact Mines	D	E	DB3	Low-Mod	DD3	Low-Mod	DB3	Low-Mod	DB3	Low-Mod	DB3	Low-Mod	EB2	Low*	DB3	Low-Mod	DB3	Low-Mod	DB3
		Axis Origin - Ground Mines	E	F	EF3	Low	ED3	Low	EC3	Low	EE3	Low	EB3	Low	FC2	Low	EC3	Low	EE3	Low	ED3
		Land Mines	E	F	EF3	Low	ED3	Low	EC3	Low	EE3	Low	EB3	Low	FC2	Low	EC3	Low	EE3	Low	ED3
		Torpedoes	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	EC2	Low	DD3	Low	DD3	Low	DD3
		Depth Charges	C	D	CD3	Low	CC3	Mod	CC3	Mod	CD3	Low	CC3	Mod	DD2	Low-Mod	CC3	Mod	CD3	Low	CC3
		Conventional Dumped Munitions	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED2	Low	DD3	Low	DD3	Low	DD3
		Dumped Chemical Munitions	E	F	EE4	Low	ED4	Low	EE4	Low	ED4	Low	EC4	Low	FD2	Low	ED4	Low	ED4	Low	EE4
		Missiles/Rockets	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DC3	Low	ED2	Low	DD3	Low	DD3	Low	DE3

UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway															
			Rock Placement	Risk Rating	Mattress Installation	Risk Rating	Peel Grab Operations	Risk Rating	Boulder Plough	Risk Rating	PLGR	Risk Rating	Borehole/Vibrocore	Risk Rating	CPT	Risk Rating	Grab Sampling	Risk Rating
Regular Munitions			Final Hazard Level															
		Small Arms Ammunition	EE5	Negligible	EF5	Negligible	EF5	Negligible	EE5	Negligible	EE5	Negligible	FF5	Negligible	FF5	Negligible	FF5	Negligible
		Land Service Ammunition	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	FE5	Negligible	FE5	Negligible	FE5	Negligible
		<155mm Projectiles	DE5	Low	DE5	Low	DE5	Low	DD5	Low	DD5	Low	EE5	Negligible	EE5	Negligible	EE5	Negligible
		>155mm Projectiles	DE5	Low	DE5	Low	DE5	Low	DD5	Low	DD5	Low	EE5	Negligible	EE5	Negligible	EE5	Negligible
		HE Bombs	DD4	Low	DE4	Low	DE4	Low	DD4	Low	DD4	Low	ED4	Low	ED4	Low	EE4	Low
		Axis Origin	DE4	Low	DE4	Low	DE4	Low	DD4	Low	DD4	Low	EP4	Negligible	EP4	Negligible	EE4	Low
		Axis Origin - Contact Mines	CB3	Mod	CD3	Low	CD3	Low	CB3	Mod	CB3	Mod	DB3	Low-Mod	DB3	Low-Mod	DD3	Low
		Axis Origin - Contact Mines	CB3	Mod	CD3	Low	CD3	Low	CB3	Mod	CB3	Mod	DB3	Low-Mod	DB3	Low-Mod	DD3	Low
		Axis Origin - Ground Mines	CE3	Low	CE3	Low	CE3	Low	CD3	Low	CD3	Low	DE3	Low	DE3	Low	DE3	Low
		Axis Origin - Contact Mines	DB3	Low-Mod	DD3	Low	DD3	Low	DB3	Low-Mod	DB3	Low-Mod	EB3	Low	EB3	Low	ED3	Low
		Axis Origin - Ground Mines	EF3	Low	ED3	Low	ED3	Low	ED3	Low	ED3	Low	FD3	Low	FD3	Low	FD3	Low
		Land Mines	EE5	Negligible	EE5	Negligible	EE5	Negligible	ED5	Low	ED5	Low	FE5	Negligible	FE5	Negligible	FE5	Negligible
		Torpedoes	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED3	Negligible	ED3	Negligible	EE3	Negligible
		Depth Charges	CD3	Low	CC3	Low	CC3	Low	CC3	Mod	CC3	Mod	DD3	Low	DD3	Low	DE3	Low
		Conventional Dumped Munitions	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD3	Low	EE3	Low	EE3	Low	EE3	Low
		Dumped Chemical Munitions	ED4	Low	EE4	Low	EE4	Low	ED4	Low	ED4	Low	FE4	Negligible	FE4	Negligible	FE4	Negligible
		Missiles/Rockets	DD3	Low	DE3	Low	DE3	Low	DD3	Low	DD4	Low	EE3	Low	EE3	Low	EE3	Low

Area	Approx. Depth Range (m LAT)	UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway																	
Zone D	>10m	Regular Munitions			Final Hazard Level																	
					Cable Lay	Risk Rating	Ploughing	Risk Rating	Vessel Mounted Jetting	Risk Rating	Tracked Vehicle Jetting	Risk Rating	Chain Cutter	Risk Rating	Snag on Vessel*	Risk Rating	Dredging	Risk Rating	MFE	Risk Rating	Anchoring	
		Small Arms Ammunition	E	F	EF5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	EE5	Negligible	FE3	Low	EE5	Negligible	EE5	Negligible	EF5	
		Land Service Ammunition	E	F	EE5	Negligible	ED5	Low	EE5	Negligible	ED5	Low	ED5	Low	FD2	Low	ED5	Low	ED5	Low	EE5	
		s155mm Projectiles	D	E	DF5	Negligible	DD5	Low	DD5	Low	DF5	Negligible	DD5	Low	ED2	Low	DD5	Low	DD5	Low	DD5	
		>155mm Projectiles	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	EC2	Low	DD4	Low	DD4	Low	DD4	
		HE Bombs	D	E	DF4	Low	DD4	Low	DD4	Low	DF4	Low	DD4	Low	EC2	Low	DD4	Low	DD4	Low	DD4	
		Axis Origin	C	D	CC3	Mod	CC3	Mod	CC3	Mod	CC3	Mod	CC3	Mod	DB2	Low-Mod	CC3	Mod	CC3	Mod	CC3	
		Allied Origin - Contact Mines	C	D	CF3	Low	CD3	Low	CC3	Mod	CE3	Low	CB3	Mod	DD2	Low	CD3	Low	CF3	Low	CE3	
		Allied Origin - Ground Mines	C	D	EB3	Low	EB3	Low	EB3	Low	EB3	Low	EB3	Low	FB2	Low	EB3	Low	EB3	Low	EB3	
		Axis Origin - Contact Mines	E	F	EF3	Low	ED3	Low	EC3	Low	EE3	Low	EB3	Low	FC2	Low	EC3	Low	EE3	Low	ED3	
		Axis Origin - Ground Mines	E	F	ED5	Negligible	ED5	Negligible	ED5	Negligible	ED5	Negligible	ED5	Negligible	FD2	Low	ED5	Negligible	ED5	Negligible	ED5	
		Land Mines	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	EC2	Low	DD3	Low	DD3	Low	DD3	
		Torpedoes	C	D	CD3	Low	CC3	Mod	CC3	Mod	CC3	Mod	CC3	Mod	DC2	Low-Mod	CC3	Mod	CD3	Low	CC3	
		Depth Charges	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED2	Low	DD3	Low	DD3	Low	DD3	
		Conventional Dumped Munitions	E	F	EE4	Low	ED4	Low	EE4	Low	ED4	Low	EC4	Low	FD2	Low	ED4	Low	ED4	Low	EE4	
		Dumped Chemical Munitions	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DC3	Low	ED2	Low	DD3	Low	DD3	Low	DE3	
		Missiles/Rockets	D	E																		

UXO	Probability of Encounter on Seabed	Probability of Encounter on Vessel*	Activity / Pathway													
Regular Munitions			Final Hazard Level													
			Rock Placement	Risk Rating	Mattress Installation	Risk Rating	Peel Grab Operations	Risk Rating	Boulder Plough	Risk Rating	PLGR	Risk Rating	Borehole/Vibrocore	Risk Rating	CPT	Risk Rating
Small Arms Ammunition	E	F	EE5	Negligible	EF5	Negligible	EF5	Negligible	EE5	Negligible	EE5	Negligible	FF5	Negligible	FF5	Negligible
Land Service Ammunition	E	F	DE5	Low	DE5	Low	DE5	Low	DE5	Low	DE5	Low	EE5	Negligible	EE5	Negligible
s155mm Projectiles	D	E	ED5	Low	ED5	Low	ED5	Low	DD5	Low	DD5	Low	EE5	Negligible	EE5	Negligible
>155mm Projectiles	D	E	DD4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	ED4	Low	ED4	Low
HE Bombs	D	E	DF4	Low	DD4	Low	DD4	Low	DD4	Low	DD4	Low	ED4	Low	ED4	Low
Axis Origin	C	D	CC3	Mod	CC3	Low	CC3	Low	CC3	Mod	CC3	Mod	DB3	Low-Mod	DB3	Low-Mod
Allied Origin - Contact Mines	C	D	CE3	Low	CE3	Low	CE3	Low	CC3	Mod	CC3	Mod	DE3	Low	DE3	Low
Allied Origin - Ground Mines	C	D	EB3	Low	ED3	Low	ED3	Low	EB3	Low	EB3	Low	FB3	Low	FB3	Low
Axis Origin - Contact Mines	E	F	EF3	Low	ED3	Low	ED3	Low	ED3	Low	ED3	Low	FD3	Low	FD3	Low
Axis Origin - Ground Mines	E	F	ED5	Negligible	ED5	Negligible	ED5	Negligible	ED5	Negligible	ED5	Negligible	FE5	Negligible	FE5	Negligible
Land Mines	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	ED3	Low	ED3	Low
Torpedoes	C	D	CD3	Low	CC3	Mod	CC3	Mod	CC3	Mod	CC3	Mod	DD3	Low	DD3	Low
Depth Charges	D	E	DD3	Low	DD3	Low	DD3	Low	DD3	Low	DD3	Low	EE3	Low	EE3	Low
Conventional Dumped Munitions	E	F	EE4	Low	ED4	Low	EE4	Low	ED4	Low	ED4	Low	FE4	Negligible	FE4	Negligible
Dumped Chemical Munitions	D	E	DE3	Low	DD3	Low	DE3	Low	DD3	Low	DD3	Low	EE3	Low	EE3	Low
Missiles/Rockets	D	E														

Probability: A = high probability to F = Low probability
Consequence: 1 = High to 5 = Low

Final Hazard Level: Encounter (Detonation - Consequence)

Risk Levels:

High
Moderate
Low-Moderate
Low
Negligible

Notes:

For 'Hazard Levels on Seabed' the depth is stated at the top left of this page
For 'Hazard Levels on Vessel' the depth is Surface (0 m)
All Hazard Levels given are prior to any mitigation
(Detonation - Consequence) Levels are taken from worksheet Hazard_Eval-1
Snag on Vessel refers to any possibility of snagging UXO and transferring to vessel
The final risk rating is based on the highest score for each activity
* Low Risk based on low Probability of Encounter despite high Probability and Consequence of Detonation
* For encounter of Chemical Munitions on vessel, the likelihood of snag on vessel resulting from retrieval of cable is considered to be minimal but this does not include residues contaminating equipment

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ANNEX B. CONSEQUENCE LEVELS

		EXPECTED CONSEQUENCES / IMPACTS			
		Human Health/ Safety	Environment	Financial Impact	
				Plant and Equipment	Structures
CONSEQUENCE LEVEL	1	Fatalities Over Extended Area	Major – Full Scale Response Required	Multiple Unit Destruction	Widespread Structural Collapse
	2	Localised Fatalities	Major – Full Scale Response Required	Unit Destruction	Localised Structural Collapse
	3	Serious Injury	Serious Resource Required	Component Replacement / Repairs Required	Structural Damage
	4	Injury Requiring Medical Treatment	Moderate/Limited Response Required	Superficial Damage	Non-Structural / Superficial Damage
	5	Minor Impact/First Aid	Minor Response Required	Minor/ No notable effect	Minor/ No notable effect

Probability Level	
A	Highly Probable
B	Probable
C	Possible
D	Remote
E	Improbable
F	Highly Improbable

Project: Bowdun OWF, Thistle Wind Partners

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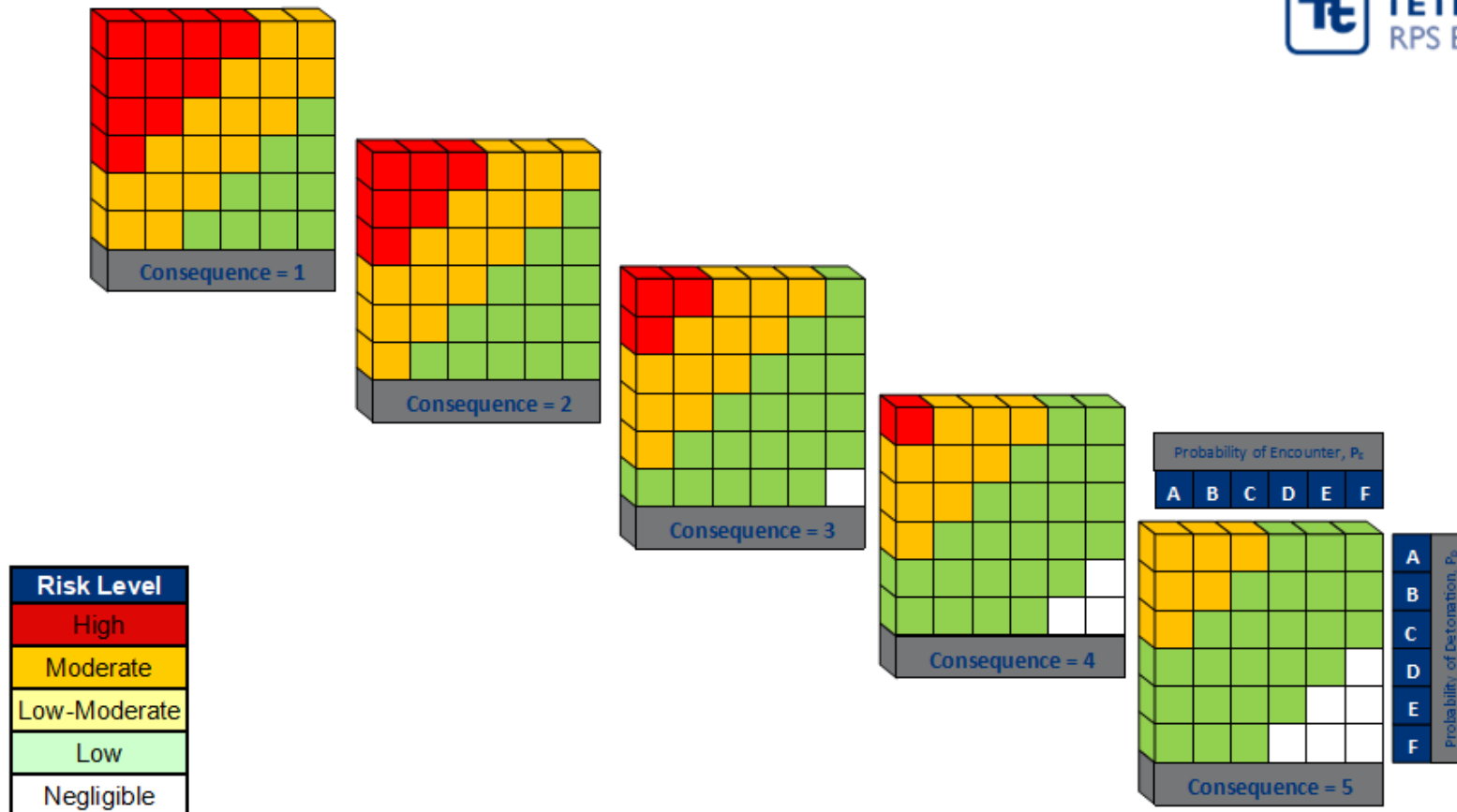
Annex B: Consequence Levels 1 of 2



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Annex B: Consequence Levels 2 of 2

ANNEX C. STANDOFF SCHEMATIC

