Supplementary Unexploded Ordnance (UXO) Information for Orsted Wind Farm Construction, US East Coast

Submitted to:
National Marine Fisheries Service
Office of Protected Resources
Silver Spring, MD

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1. Purpose and Need

For the purposes of the memo, the Orsted Projects of Ocean Wind 1, Sunrise Wind, and Revolution Wind have evaluated the risk of encountering unexploded ordnance/Munitions and Explosives of Concern (UXO/MEC) in their Project areas. These may include explosive munitions such as bombs, shells, mines, torpedoes, etc. that did not explode when they were originally deployed or were intentionally discarded to avoid land-based detonations. Underwater detonations of UXO/MEC may be necessary in some situations due to human safety considerations and other factors.

Underwater noise from UXO detonations can impact marine animals through mortality, physical injury, auditory damage, physiological stress, acoustic masking, and behavioral responses (Merchant et al. 2020). The behavior of the pressure wave in the water column depends on water depth, sediment, sea state, stratification of the water column, temperature, salinity, and other variables (Koschinski and Kock 2009; Salomons et al. 2021). The specific effects on a given marine mammal will depend on all of these factors, as well as species, body size, the distance of the animal from the blast site, and the charge weight of the UXO in question (Hannay and Zykov 2021). Each Project has therefore proposed protective mitigation zone sizes taking these factors into account, based on results of underwater sound propagation modeling specific to UXO detonation (see **Section 4**). We note that the chosen values for pre-start clearance zones were the most conservative per charge weight bin across each of the four modeled sites.

NMFS has indicated within the Draft Rule for Incidental Take of each respective Project (Ocean Wind 1, Revolution Wind, and Sunrise Wind), that until each Project can more clearly demonstrate the ability to identify UXO/MEC size in the field, the most protective zone sizes will be required in order to ensure the least practicable adverse impact on marine mammals. The revised zones are based on (but not equal to) the greatest TTS threshold distances from 454 kg charge at any site modeled.

The supplementary information provided in this document is intended to demonstrate Orsted's ability to accurately determine the charge weight of UXO/MEC encountered in the field. Because of this demonstrated ability, Orsted requests that NMFS develop UXO clearance zones within the Final Rule for Incidental Take for each Project specific to the charge weight identified, rather than applying zones for the largest charge weight (454 kg) of an encountered UXO.

The information presented within this memo is also intended to provide a basis for all North America Orsted Projects in relation to the identification of UXO/MECs.

2. Risk Management and Mitigation

Each Project follows an industry standard As Low as Reasonably Practical (ALARP) process that minimizes the number of potential detonations. While avoidance is the preferred approach for UXO/MEC mitigation, there may be instances when confirmed UXO/MEC avoidance is not possible due to layout restrictions, presence of archaeological resources, or other factors that preclude micrositing. In such situations, confirmed UXO/MECs may be removed through physical relocation or in situ disposal. Physical relocation will be the preferred method but is not an option in every case. Selection of a removal method will depend on the location, size, and condition of the confirmed UXO/MEC, and will be made in consultation with a UXO/MEC specialist and in coordination with the agencies with regulatory oversite of UXO/MECs. For UXO/MECs that will require in situ disposal, it will be done with low order methods (deflagration), high order (detonation), or cutting of the UXO/MEC to extract the explosive components.

Risk associated with UXO/MEC detonation is minimized using an ALARP approach (**Figure 1**). For a risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained. The ALARP principle arises from the fact that infinite time, effort, and money could be spent on the attempt of reducing a risk to zero.

The Risk Management Framework (RMF) to be followed for each project, shown in **Figure 2**, is in accordance with the ALARP principle.

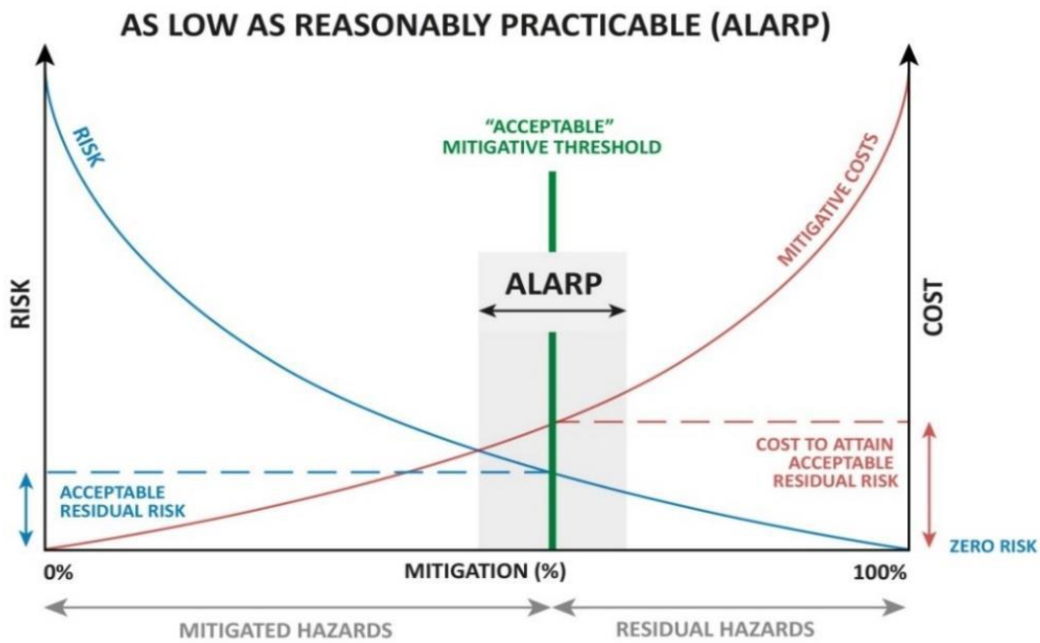

Figure 1. Determining risks are ALARP by measuring cost versus effort.

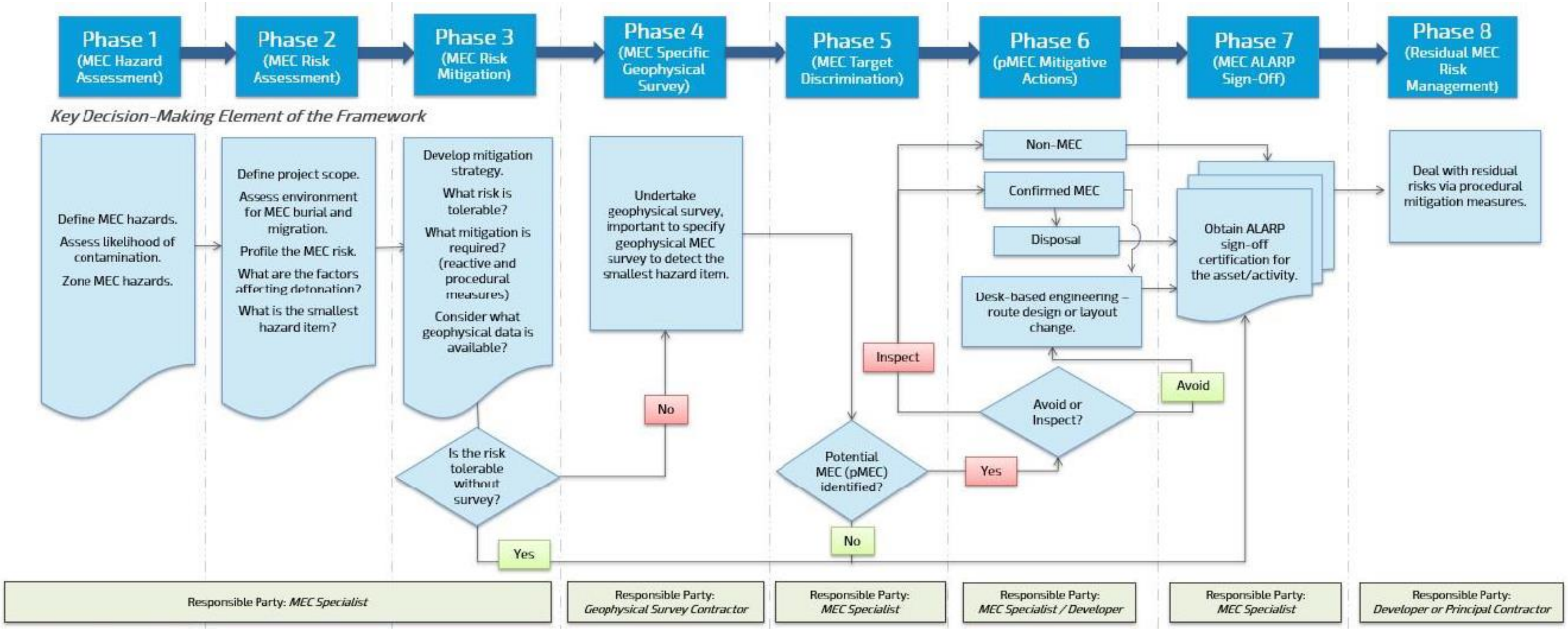

Figure 2. The Risk Management Framework (RMF) followed by each Project for the reduction of UXO/MEC risks. The RMF consists of eight interrelated and sequential phases, which are in accordance with the ALARP principle.

3. Historical Research and Hazard Profiling

Ordtek's research typically identifies UXO/MEC sources that have the potential to contaminate the Project area. They assess what they consider to be the most likely UXO/MEC hazards in the Study Area, now and across the life of the Project, including the most likely types that could be encountered and the likelihood of encountering them.

Military archives and data sets - particularly older ones, are often very limited in both accuracy and detail. Determining specific and complete evidence of the amount of munitions dumped, laid, fired, or dropped, live or inert is very rarely possible. Positional information drawn from historical documents, for activities such as minelaying, should always be treated with caution. The navigation equipment in use at the time was rudimentary compared to systems available today, and inherent errors were compounded in transmission and exacerbated by the confusion of war.

In the desk-based study, Ordtek considers both wider regional and, where the information is available, Project-specific historical factors for the purpose of determining a baseline UXO/MEC hazard level.

Research focuses on the following:

1. Military history of the area
2. Official and unofficial munitions dumping sites
3. Current and historical military weapon ranges and training areas
4. Evidence of naval surface and subsurface warfare and engagements
5. Evidence of aerial warfare, including bombing, depth charge and torpedo deployment

While the European theatre undoubtedly saw considerably more combat during WWI and WWII than the East Coast of the US, there was a significant amount of German U-boat activity conducted against American and Allied shipping during both World Wars. Evidence of these activities can be seen in the number of wrecks caused by mine laying operations and torpedo attacks. There is, therefore, a hazard from these munitions across all North American Projects. There are further hazards from training activities and test firing by coastal artillery, as the East Coast has been used for coastal defense and training by the US armed forces for centuries. Finally, there is a hazard from jettisoned bombs off the east coast due to the presence of a designated jettison area for training, which are outlined in BOEM guidance.

It is important to note that the positions shown on the charts may not always be accurate. Mine lays, indeed all operations, were conducted under tension of war with rudimentary navigation systems. Moreover, mining was not always accurately recorded and after the war many original records were lost. The positions of the minefields could be out by hundreds of meters or, in some cases, several kilometers. This is also true of wrecks sunk due to military action.

Table 1 summarizes the potential UXO/MEC items which may be found within a Project Area, including their approximate net explosive quantity (NEQ) and their source of origin. This table is a summary of the most likely items and should not be considered an exhaustive list of all the potential items of UXO/MEC that may be encountered.

Table 1: Potential MEC items across North America's East Coast

UXO/MEC Type	NEQ (Approximate)	Total Length	Width	Diameter	Total Weight	Source
Small Items of UXO/MEC						
Machine Gun ammunition	None	40.8mm	7.62mm	7.62mm	Variable	Training activities, jettisons, used by vessels engaged in anti-submarine warfare
20mm cannon ammunition	Negligible	127mm	20mm	20mm	Variable	
37mm HE ammunition (and inert ball)	Negligible	223mm	37mm	37mm	Variable	
40mm HE ammunition (and inert ball)	Negligible	311mm	40mm	40mm	Variable	
90mm HE ammunition (and inert ball)	>2kg	600mm	90mm	90mm	Variable	
120mm HE ammunition (and inert ball)	>3kg	775mm	120mm	120mm	Variable	
AIM-9 Air to air missile	Max 11kg continuous rod, likely inert training but cannot be assumed	3.20m	127mm	127mm	War head weight: 9.4kg Mass: 85.3kg	General aerial training
8.8cm U-boat Deck Gun ammunition	Negligible	355mm	880mm	880mm	15kg	WWII U-boat attacks
Medium Items of UXO/MEC						
250lb MC bomb	~55kg	1.21m	0.25m	0.25m	113.4kg	Bombing training/ jettisons
WWII US Mark 24 Fido Torpedo	42kg	2.13m	0.48m	0.48m	308kg	US Torpedo training
Large Items of UXO/MEC						
16-inch HE projectile	305kg	1620mm	406mm	406mm	1015kg	Camp Hero
500lb MC bomb	~118kg	1.20m (body length)	0.36m	0.36m	226.8kg	Bombing training/

		1.50m (total length)				jettisons
1000lb MC bomb	~239kg	1.84m	0.45m	0.45m	453.6kg	
2000lb MC bomb	~483kg	2.78m	0.76m	0.76m	907.2kg	
WWI U-boat Torpedo (Multiple variants)	Max 179kg, 45 cm (17.7-inch) C45/91S (Excluding J9)	C45/91S: 5.1m	C45/91S: 0.45m	C45/91S: 0.45m	C45/91S 550kg	WWI U-boat attacks
WWII U-boat Torpedo (Multiple variants)	Max 280kg, 53.3 cm (21-inch) G7a T1	G7a T1: 7.2m	G7a T1: 0.5m	G7a T1: 0.5m	G7a T1: 1528kg	WWII U-boat attacks
WWII US Torpedo (Multiple Variants	Max 363kg Mark 15, 21-inch (53.3cm)	Mark 15: 7.3m	Mark 15: 0.5m	Mark 15: 0.5m	Mark 15: 1.742kg	US Torpedo training
WWII US Depth Charge (multiple variants)	Max 272kg	IV: 0.86m V: 0.89m	IV: 0.86m V: 0.89m	IV: 0.86m V: 0.89m	IV: 281kg V: 281kg	US attacks against German U-boats
German Type IV and V mine	~82kg and ~163kg respectively	IV: 0.86m V: 0.89m	IV: 0.86m V: 0.89m	IV: 0.86m V: 0.89m	IV: 281kg V: 281kg	Unconfirmed German WWI U-boat mine lay
German TMB	554kg	1.98m	0.53m	0.53m	703kg	German WWII U-boat mine lays
US M4 Controlled Ground Mine	1363kg	1.5m	1.5m	2.3m	2727kg	US controlled minefields

4. Description of MEC/UXO Geophysical Survey

To better assess the potential UXO/MEC encounter risk, geophysical surveys are conducted to identify potential UXO/MECs (pUXO/pMECs). For the purposes of locating and identifying items that model as MEC within each Project's footprint, the geophysical sensors would include:

- Side scan sonar (SSS)
- Multibeam echosounder (MBES)
- Magnetometer

In overview the following workflow should be employed ahead of and during geophysical survey data collection:

- Establish smallest threat item and develop a technical specification to detect the item with required datasets.
- Establish survey areas.

- As part of vessel mobilization, undertake an Equipment Verification Trial (EVT) on the Project with a deployed known test item to show all sensors are working as expected and demonstrate data transfer and processing procedures.
- Pass EVT data and report to Client and MEC Consultant for review – receive EVT acceptance report.
- Acquire geophysical data sets with Client survey representative(s) onboard providing data QA/QC

The Contractor shall process data in accordance with the specification set by the MEC Consultant. The data should then be sent onshore for potential MEC target discrimination. Anomalies will be picked from the processed data that model as MEC and these 'potential MEC' will be given an exclusion distance that should not be interfered with.

5. Description of pMEC/UXO Inspections

These identification surveys are focused on inspecting pMEC/UXOs that meet criteria set forth in each Project specific Risk Assessment and which are deemed to present potential conflicts with offshore installation activities.

Objectives of the pMEC/UXO Identification Surveys are to:

- Inspect the target list of pMEC/UXO using Remotely Operated Vehicle (ROV)-based MBES, electromagnetic (EM) coil system for locating the buried ferromagnetic contacts and high-resolution digital color cameras and forward scanning sonar for visual identification of both surface and uncovered contacts;
- Uncover buried targets for visual identification of explosive ordnance (EO) or other debris;

During the inspection campaign UXO/MEC experts are onboard the vessel overseeing the works. The UXO/MEC experts have experience of performing military UXO disposal operations during their time in the military. As with all explosive ordnance disposal operations (either commercial or military) it is essential to gain a positive identification of the items in question. Firstly, to ensure the correct disposal method is deployed but also to ensure the safety of all sensitive receptors.

ROV operations involve the following procedures, depending on whether the pUXO/MEC target is expected to be buried in, or located on top of, the seabed:

- The pMEC/UXO target(s) are located using forward scanning sonar (360-degree search), MBES and EM to search within an approximately 5 m x 5 m to 15 m x 15 m inspection box (size depending on locational accuracy), centered on the pMEC/UXO location.
- If the pMEC/UXO target(s) are located on the seabed, then these are identified using high quality digital color cameras and forward scanning sonar.
- If the pMEC/UXO target(s) are (partially) buried, then fine, unconsolidated sediments are uncovered to facilitate identification.
- When the item has become fully exposed, identification of the pMEC/UXO is done by the MEC/UXO specialist by correlating the gathered data and video imagery with the items listed in Table 1. Using high quality imagery from the inspection campaign along with the historical research performed specifically for the Project site, it is possible to accurately identify the items of munitions along with the NEQ.
- If an item is identified as debris/non-MEC/UXO, it is in some cases removed from the inspection box and an electromagnetic survey is performed to ensure that no MEC/UXOs are missed due to ferromagnetic masking. These decisions are made at the discretion of the MEC/UXO specialist.
- Finally, a MBES out-survey, consisting of 1-2 survey lines over the area/target, is conducted.

Following the completion of each pMEC/UXO target location survey, a target inspection report (TIR), including location, target identification, data maps and video stills, is produced and reviewed on board the vessel. If there is any uncertainty during the identification process, then the TIR along with the data and videos will be passed on to an onshore MEC/UXO consultant for further review.

Confirmed UXO/MECs identified during the inspection campaign for each respective Project is detailed in Appendix A. The confirmed UXOs listed within Appendix A will be avoided during the construction of each of the Projects. However, undiscovered UXOs or emergent finds present a ubiquitous risk throughout each Project area. So, while to date there are no identified UXOs that require in-situ disposal, the risk of emergent finds will continue to be a consideration. The process for emergent find discovery and mitigation is further detailed in Section 7.

6. Protective Mitigation and Monitoring Measures for UXO/MEC Detonation

The primary mitigation and monitoring measures associated with UXO/MEC detonation are:

- Pre-start clearance
- PAM operators and an associated mitigation PAM array in support of the visual PSOs
- Noise Mitigation Systems (NMS)
- Post-detonation monitoring
- Acoustic measurement data collection to verify distances to regulatory or mitigation zones.

Detailed mitigation and monitoring measures for UXO/MEC detonations are provided in the Protected Species Mitigation and Monitoring Plan for each Project and in **Appendix B**.

Mitigation zones for UXO detonation are based on the results of underwater sound propagation modeling specialized for this noise source (Hannay and Zykov 2021). Modeling was undertaken to estimate the threshold distances for onset of TTS and PTS for all functional hearing groups of marine mammals using the frequency-weighted SEL metric, for a selection of charge weights spanning all potential UXO types that may be encountered. Non-auditory injury (mortality and slight lung injury) threshold distances were modeled using the peak pressure (PK) metric, for five species groups based on body mass. The charge weight bins were categorized and labeled as follows (2.3 kg [E4]; 9.1 kg [E6]; 45.5 kg [E8]; 227 kg [E10]; 454 kg [E12]). Propagation modeling was performed using a sound speed profile representative of September, as this represented the most conservative noise propagation scenario (Hannay and Zykov 2021).

All mitigation and monitoring zones assume the use of an NMS resulting in a 10 dB reduction of noise levels (Hannay and Zykov 2021; Bellman and Betke, 2021). Mitigation and monitoring zones specific to marine mammal hearing groups for the five different charge weight bins are presented in **Appendix B** (assuming 10 dB mitigation). The full suite of threshold distances for non-auditory injury (impulse metric), as well as PTS and TTS (PK and SEL metrics) are presented in Hannay and Zykov (2021). Non-auditory injury and PTS are considered Level A harassment, and TTS is considered Level B harassment. Because each Project has committed to no more than a single detonation event in any given 24-hour period, no behavioral modifications are anticipated (Hannay and Zykov 2021). In all cases, the modeled distance to auditory injury (PTS) was greater than the distance to mortality and non-auditory injury thresholds (Hannay and Zykov 2021), so all Level A distances presented are PTS. Four different sites (S1–S4; one within shallow depths representative of cable routes and the other three within depths representative of wind farm areas) ranging from 12–45 m were chosen to model the threshold distances for each of the five bins. PTS and TTS zones were calculated for each charge weight bin (E4–E12) by selecting the largest noise metric value across each of the four sites.

7. Communication Procedures to be Followed if an Emergent Find is Encountered

Should an emergent find be encountered during construction of each of the Projects, Orsted will have an Explosive Ordnance Disposal (EOD) Contractor on call throughout the duration of construction. The process for identification and confirmation of a pUXO/pMEC as outlined in Section 5 will be followed. The method of disposal will be determined by the ALARP process, as outlined in Section 2, should the pUXO/pMEC be a confirmed UXO/MEC.

Each Project will also be creating an Emergent Finds Plan for submittal and approval to BOEM. Should an emergent find be discovered during construction, each Project will follow the appropriate protocol as outlined within the prepared Emergent Finds Mitigation Plan, and will coordinate appropriately with the state and federal agencies.

Figure 3, featured below, outlines the anticipated communication process with federal and state agencies.

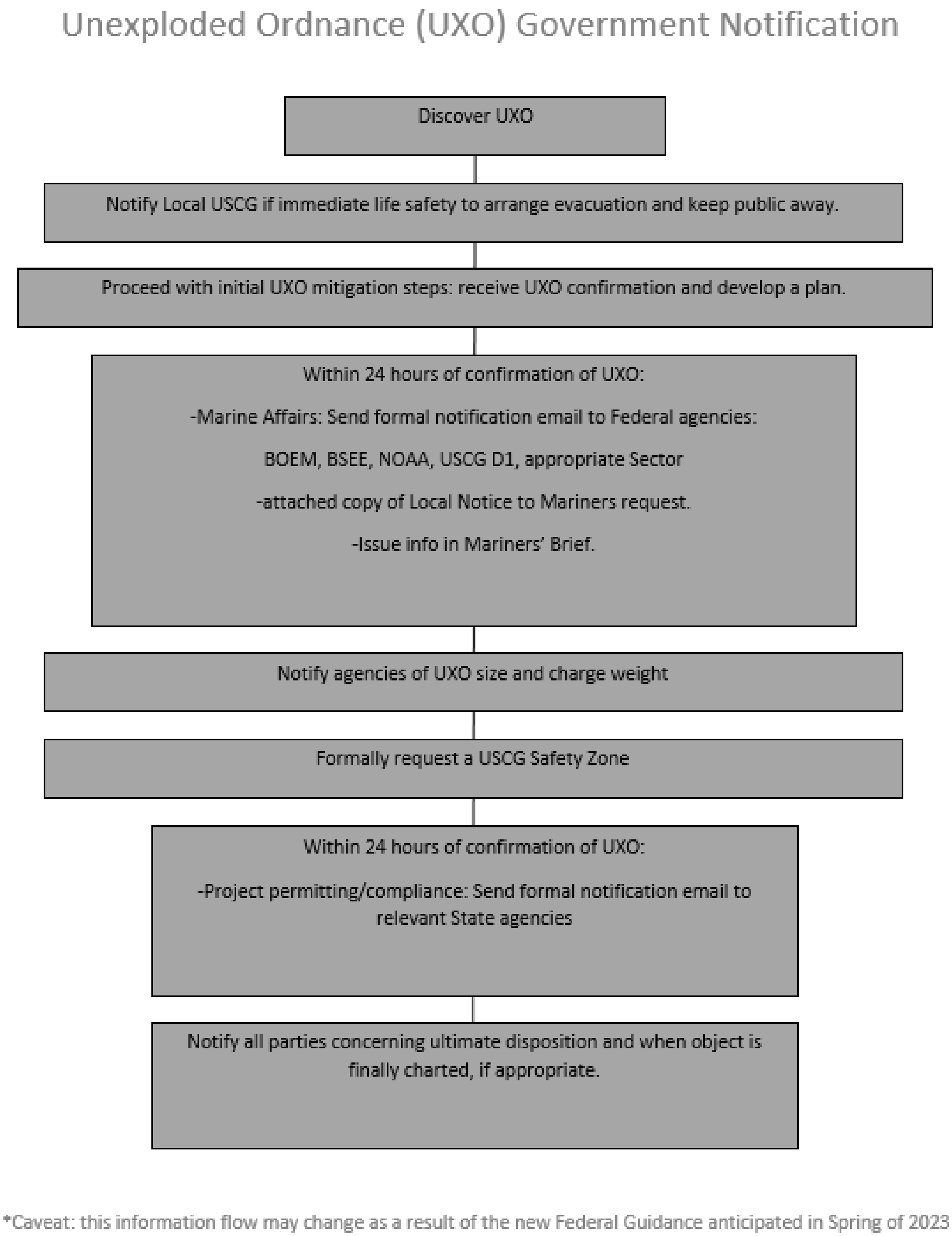

Figure 3. Communication process with federal and state agencies if an emergent find (pMEC) is encountered.

8. References

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Appendix A

Confirmed UXOs/MECs in the Project Area

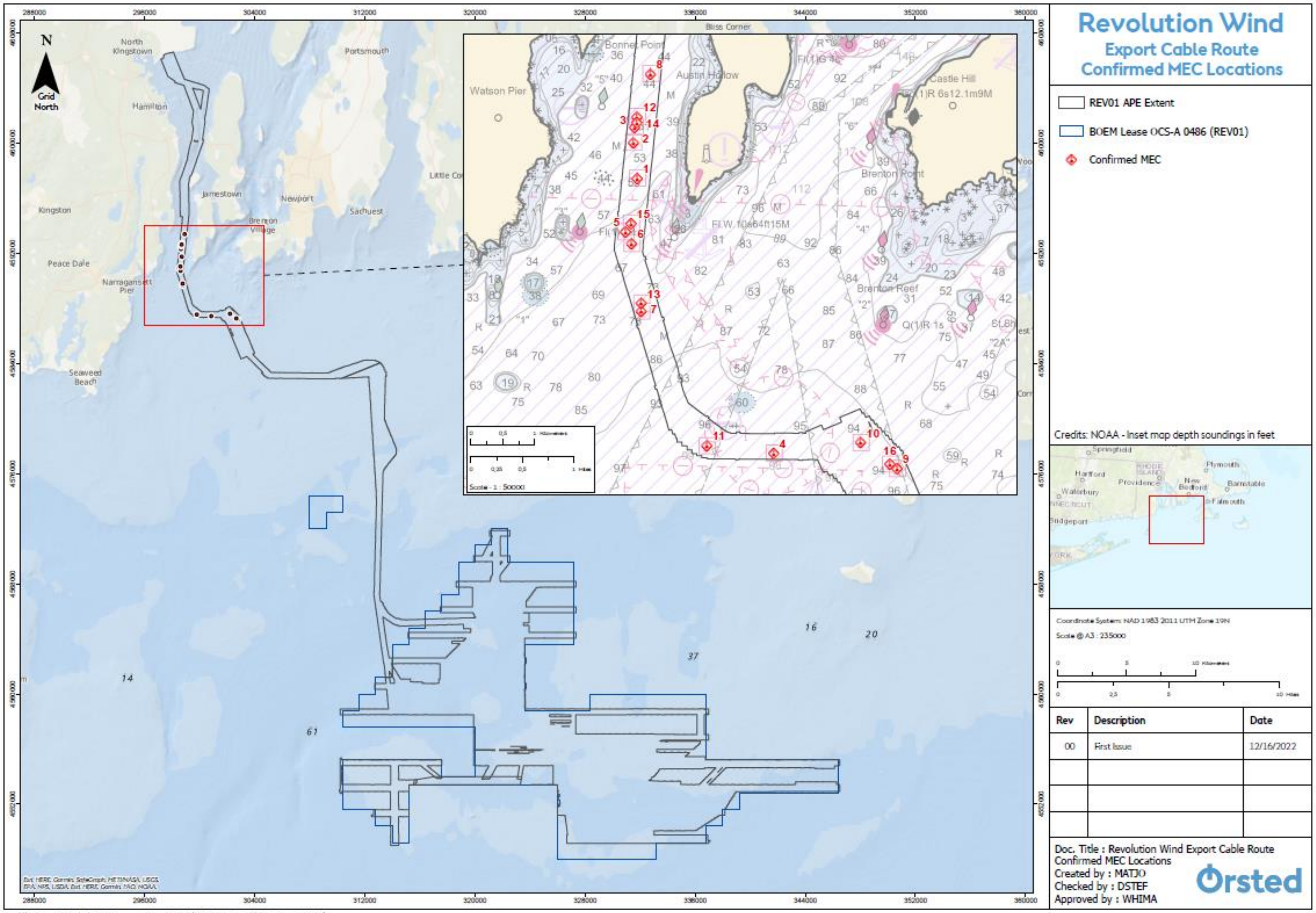
Table A-1: Locations of Confirmed UXOs/MECs within the Revolution Wind Export Cable Route and the Revolution Wind Farm Lease Area

Notification No.	Latitude (DD mm.mmm)	Longitude (DD mm.mmm)
1	41°27.128'N	071°24.594'W
2	41°27.429'N	071°24.649'W
3	41°27.560'N	071°24.639'W
4	41°24.830'N	071°22.969'W
5	41°26.672'N	071°24.709'W
6	41°26.574'N	071°24.637'W
7	41°26.003'N	071°24.508'W
8	41°28.016'N	071°24.478'W
9	41°24.729'N	071°21.574'W
10	41°24.942'N	071°21.994'W
11	41°24.877'N	071°23.727'W
12	41°27.64801'N	071°24.61631'W
13	41°26.07208'N	071°24.50986'W
14	41°27.60394'N	071°24.61711'W
15	41°26.74516'N	071°24.64957'W
16	41°24.76545'N	071°21.65848'W

Table A-2: Location of Confirmed UXOs/MEC within the Sunrise Wind Export Cable Route and the Sunrise Wind Farm Lease Area

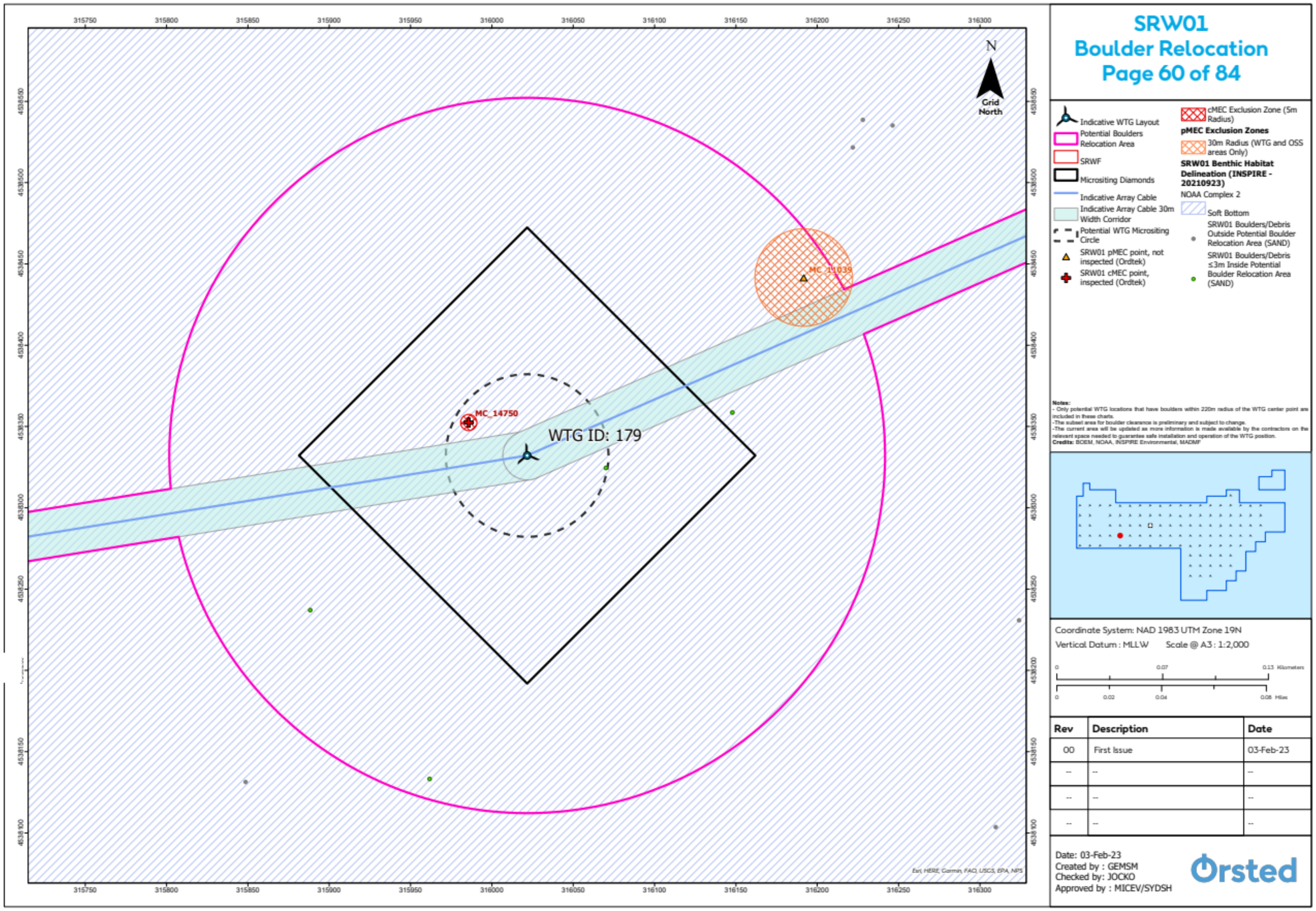
Notification No.	Latitude (DD mm.mmm)	Longitude (DD mm.mmm)
1	40°58.536'N	071°11.225'W

Figure A-1: Confirmed UXOs/MECs within the Revolution Wind Export Cable Route and Revolution Wind Farm Lease Area



User: MATJO Date: 16-12-2022 Name: REV01_1410_ECR_Confirmed_MEC_Locations_20221214

Figure A-2: Confirmed UXO/MEC within the Sunrise Wind Export Cable Route and Sunrise Wind Farm Lease Area



Appendix B

Project Specific Mitigation and Monitoring Zones

Table B-1: Ocean Wind 1 Mitigation and Monitoring Zones Associated with UXO Detonation of Binned Charge Weights, with a 10 dB Noise Mitigation System as proposed by the by OCW01 ITR Application and PSMMP.

Species	UXO Charge Weight[1]									
	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
	Pre-Start Clearance Zone[2] (m)	Level B Monitoring Zone[3] (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)
Low-Frequency Cetaceans										
Fin whale* Minke whale Sei whale* Humpback whale NARW* Blue whale*	552	2,820	982	4,680	1,730	7,490	2,970	10,500	3,780	11,900
Mid-Frequency Cetaceans										
Sperm whale* Atlantic white-sided dolphin Atlantic spotted dolphin Short-beaked common dolphin Risso's dolphin Bottlenose dolphin, coastal Bottlenose dolphin, offshore Long-finned pilot whale Short-finned pilot whale	50	453	75	773	156	1,240	337	2,120	461	2,550
High-Frequency Cetaceans										
Harbor porpoise	1,820	6,160	2,590	8,000	3,900	10,300	5,400	12,900	6,200	14,100
Phocid Pinnipeds										
Gray seal Harbor seal	182	1,470	357	2,350	690	3,820	1,220	5,980	1,600	7,020

* = denotes species listed under the Endangered Species Act; kg = kilograms; m = meters; PK = peak pressure level; SEL = sound exposure level.

[1] UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2021, **Appendix C**) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

[3] Level B monitoring zones were calculated by selecting the largest TTS threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

Table B-2: Sunrise Wind Mitigation and Monitoring Zones Associated with UXO Detonation of Binned Charge Weights, with a 10 dB Noise Mitigation System as proposed by the by SRW ITR Application and PSMMP.

Species	UXO Charge Weight[1]									
	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
	Pre-Start Clearance Zone[2] (m)	Level B Harassment Zone[3] (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)
Low-Frequency Cetaceans										
Fin whale*	400	2,800	800	4,500	1,600	7,300	3,000	10,300	3,700	11,800
Minke whale										
Sei whale*										
Humpback whale										
NARW*										
Blue whale*										
Mid-Frequency Cetaceans										
Sperm whale*	50	500	50	800	100	1,300	4000	2,100	500	2,500
Atlantic white-sided dolphin										
Atlantic spotted dolphin										
Short-beaked common dolphin										
Risso's dolphin										
Bottlenose dolphin, coastal										
Bottlenose dolphin, offshore										
Long-finned pilot whale										
Short-finned pilot whale										
High-Frequency Cetaceans										
Harbor porpoise	1,800	6,200	2,600	7,900	3,900	10,100	5,400	12,600	6,200	13,700
Phocid Pinnipeds										
Gray seal	100	1,300	250	2,200	600	3,900	1,100	6,000	1,500	7,100
Harbor seal										

* = denotes species listed under the Endangered Species Act; kg = kilograms; m = meters; PK = peak pressure level; SEL = sound exposure level.

[1] UXO/MEC charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2021) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric) and rounding up for PSO clarity. The chosen values were the most conservative per charge weight bin across each of the two modeled sites representative of the Sunrise Wind Lease Area.

[3] Level B harassment zones were calculated by selecting the largest TTS threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the two modeled sites representative of the Sunrise Wind Lease Area.

Table B-3: Revolution Wind Mitigation and Monitoring Zones Associated with UXO Detonation of Binned Charge Weights, with a 10 dB Noise Mitigation System as proposed by the by REV ITR Application and PSMMP.

Species	UXO Charge Weight[1]									
	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
	Pre-Start Clearance Zone[2] (m)	Level B Harassment Zone[3] (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)	Pre-Start Clearance Zone (m)	Level B Harassment Zone (m)
Low-Frequency Cetaceans										
Fin whale* Minke whale Sei whale* Humpback whale NARW* Blue whale*	600	2,900	1,000	4,700	1,800	7,500	3,000	10,500	3,800	12,000
Mid-Frequency Cetaceans										
Sperm whale* Atlantic white-sided dolphin Atlantic spotted dolphin Short-beaked common dolphin Risso's dolphin Bottlenose dolphin, offshore Long-finned pilot whale Short-finned pilot whale	50	500	80	800	200	1,300	400	2,300	500	2,600
High-Frequency Cetaceans										
Harbor porpoise	1,900	6,200	2,600	8,000	3,900	10,300	5,400	12,900	6,200	14,100
Phocid Pinnipeds										
Gray seal Harbor seal	200	1,500	400	2,400	700	3,900	1,200	6,000	1,600	7,100

* = denotes species listed under the Endangered Species Act; m = meters.

[1] UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2021) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were determined by selecting the largest distance to a Level A threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

[3] Level B harassment zones were determined by selecting the largest distance to the TTS threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.