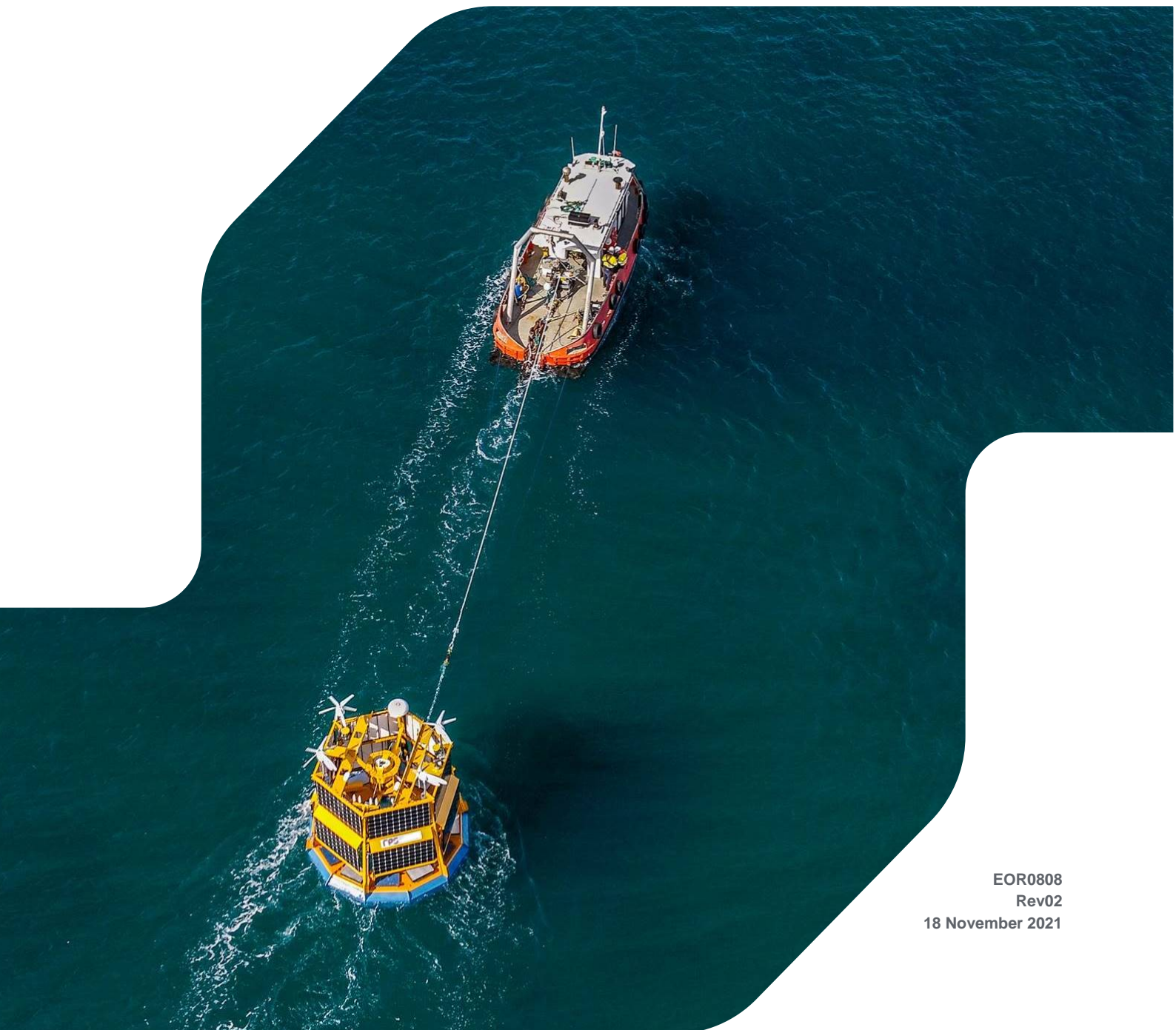


# MARINE ENERGY TEST AREAS (META)

META Phase 1 Sites Marine Licence Variation Environmental Appraisal



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**Prepared by:**

**RPS**

Samantha Tuddenham  
Marine Consultant

Goldvale House  
27-41 Church Street West  
Woking, Surrey, GU21 6DH

T +44 1483 746 500  
E [tuddenhams@rpsgroup.com](mailto:tuddenhams@rpsgroup.com)

**Prepared for:**

**Milford Haven Port Authority**

Jason Hester  
Senior Project Manager

Port of Milford Haven, Gorsewood Drive, Hakin, Milford Haven, Pembrokeshire, SA73 3EP

T +44 1646 696100  
E [jason.hester@mhpa.co.uk](mailto:jason.hester@mhpa.co.uk)

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- Appendix A : Environmental Impact Scoping Exercise
- Appendix B : WFD Scoping Table
- Appendix C : Subsea noise modelling report

# 1 INTRODUCTION

## 1.1 Background

On 10 June 2019, Pembrokeshire Coastal Forum (PCF) was awarded a Marine Licence (DEML 1875) under the Marine and Coastal Act (2009) by the Natural Resources Wales (NRW) Marine Licensing Team, on behalf of the Welsh Ministers, for the Marine Energy Test Areas (META) Phase 1 project. This Environmental Appraisal has been prepared by RPS Energy in support of a variation to the awarded Marine Licence.

The META project provides a series of pre-consented, non-grid connected, marine energy test areas that enables the deployment and testing of devices, components and subassemblies, ancillary activities, and equipment, in support of marine energy testing, thereby de-risking marine energy projects prior to larger scale or array deployments and reducing the consenting burden on device developers. The META project comprises eight sites in total and was consented under two separate routes:

- META Phase 1 sites (Site 1 – Carr Jetty, Site 2 – Mainstay Quay, Site 3 – Ferryside, Site 4 – Quay 1, and Site 5 – Criterion Jetty) within the Pembroke Dock area of the Milford Haven waterway, were deemed to have low to negligible impacts on the environment due to their locations, size, nature, and scale of activities proposed and therefore required a Band 2 Marine Licence; and
- META Phase 2 sites (Site 6 – Warrior Way, Site 7 – Dale Roads, and Site 8 – East Pickard Bay) were subject to an Environmental Impact Assessment (EIA) and separate Marine Licence.

This proposed variation to the awarded Marine Licence is relevant to the META Phase 1 Site 3 - Ferryside only (Figure 1.1). The awarded META Phase 1 Marine Licence included for the installation of a permanent floating pontoon to support the META testing activities at this site. Milford Haven Port Authority (MHPA), who are undertaking these works, have recently undertaken the early contractor design process with their consultant engineers. This process has resulted in a recommendation to increase the number of pontoons to be installed from four to five and to increase the size of each pontoon from the current licenced size of 2 m x 26 m to 5 m x 25 m (increasing the total length of the pontoons from 104 m to 125 m). The awarded META Phase 1 Marine Licence allowed for the floating pontoons to be tethered to the existing dolphins at this site but there is now the requirement for 10 monopiles to be installed to the south of the existing dolphins, to which the pontoons will be attached. This change is required to accommodate the new Irish Ferries vessel forces and to future proof for changes to ferry vessel type/power.

The aim of this environmental appraisal is to provide information on the proposed additional activities at the META Phase 1 Site 3 - Ferryside to support the submission of a Marine Licence variation application.

# META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

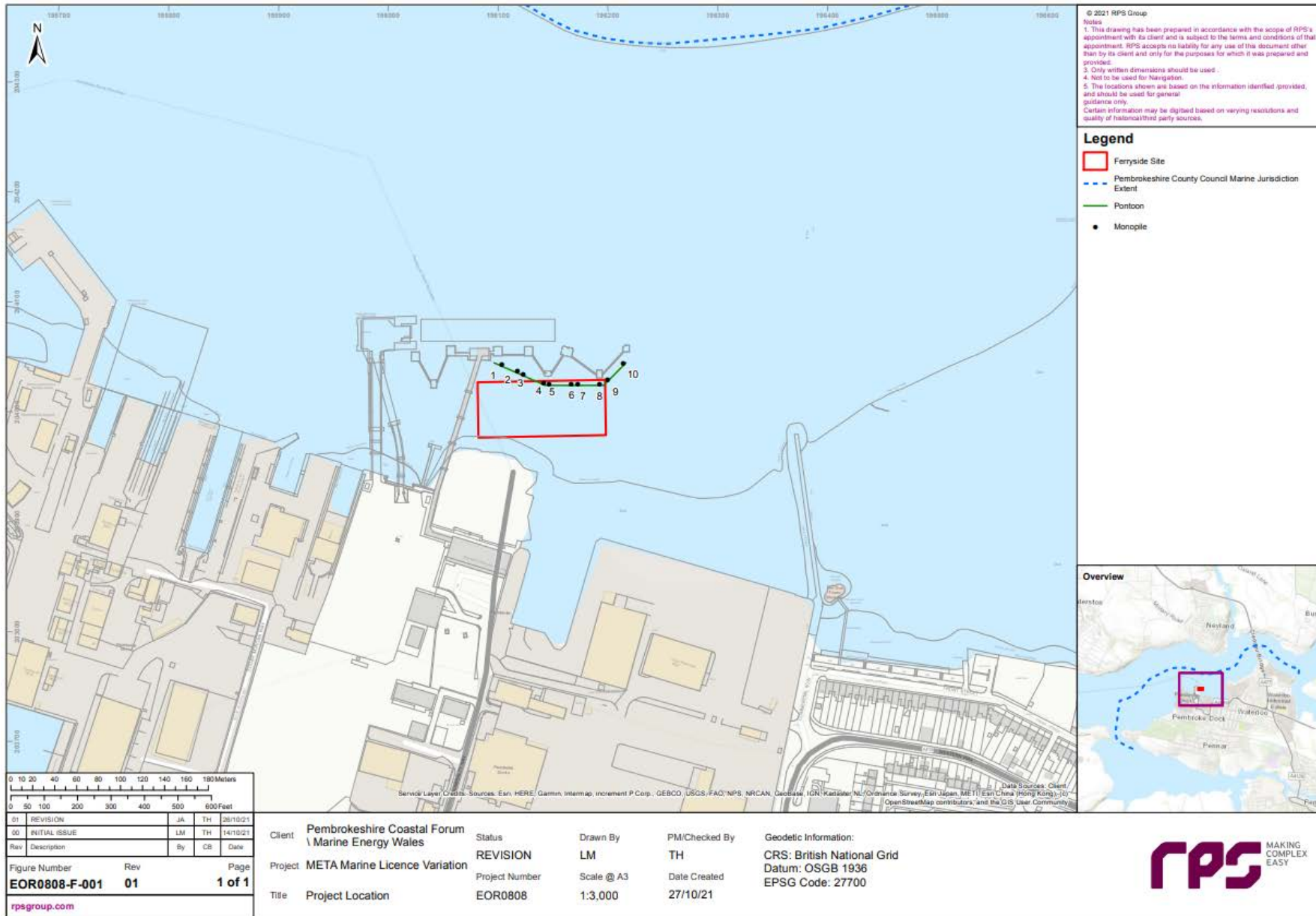


Figure 1.1: META Phase 1 Site 3 - Ferryside location

## **1.2 Consultation**

Consultation undertaken by MHPA with Natural Resources Wales – Marine Licencing Team (NRW-MLT) in August 2021, via video conference, confirmed that these proposed activities are categorised as a complex variation to the Band 2 Marine Licence and do not require a new marine licence application.

Consultation with NRW-MLT in October 2021 was undertaken to confirm the approach to the marine licence variation and NRW-MLT requested a table outlining the proposed updates against the currently licence parameters and their predicted environmental impact.

## 2 PROJECT DESCRIPTION

### 2.1 Licensable activities

Under the Marine and Coastal Access Act 2009, a Marine Licence is required to construct, alter, or improve any works within the UK marine licensing area.

The awarded META Phase 1 Marine Licence included for the installation of a permanent floating workboat pontoon, comprising of four inter-connected pontoons, at the existing Ro-Ro ferry berth at Pembroke dock, adjacent to the META Phase 1 Site 3 – Ferryside. The floating pontoons were originally intended to be tethered to the existing dolphins at this site and would serve a range of crew transfer vessels and other vessels supporting offshore renewable energy development. The Applicant is seeking consent for the installation of ten new monopiles to which the pontoons will attached instead of the consented design which involved attachment of the pontoons to the dolphin moorings (Table 2.1).

The Applicant is also seeking consent for a variation to the design of the pontoons which will see the number of pontoons increasing from four to five and an increase in the size of each pontoon from 2 m x 26 m to 5 m x 25 m (increasing the total length of the pontoons from 104 m to 125 m).

The five pontoons will be tethered to the ten new monopiles. Furthermore, two pontoons (D and E) will have additional pile fixings to ensure the location of the pontoons can be adjusted if required (Figure 3.1). The works will also include non-marine based activities e.g. improving the existing access onto the existing dolphins and providing a new access brow to the work boat pontoons. The new access system between the T-head pontoon and the existing dolphins will comprise a combination of new steps, walkway, and access gangway.

A design life of 50 years is required for the pontoons, restraint system (including piles) and access brow structures with first significant maintenance at 25 years subject to routine maintenance of wearables elements such as pontoon restraint guides and fenders and repair of routine wear and tear. The design will incorporate a cathodic protection system intended to provide supplementary protection as the paint systems reach the end of their life. The applicant intends to apply for a new marine licence at its expiry date (June 2029) to cover the presence of the pontoon and maintenance activities and its 50 year lifetime. Any maintenance works that fall outside those included in the original licence (“Pontoon to be in-situ all year round with removals for maintenance every five years”) will therefore be consented via additional Marine Licence applications in the future.

A summary of the design parameters associated with pontoon and monopile installation activities are provided below in Table 2.1.

**Table 2.1: Summary of project parameters**

Parameter description	Licensed parameter value	Variation parameter value
<b>Construction</b>		
Number of new workboat pontoons	4	5
Total combined length of new berths	104 m	125 m
Pontoon width	2 m	5 m
Pontoon material	Steel or concrete	Steel or concrete
Pontoon restrain system	Guides mounted to existing dolphins	Guides mounted on new independent monopiles
Number of piles	0	10
Pile diameter	n/a	1,220 mm
Pile installation methodology	n/a	Rotary drilling or top drive drilling
Total duration of activities	21 days	60 days (July-September 2022)
<b>Operation and Maintenance</b>		
Design life	50 years	50 years

## 2.2 Method Statement

Installation of the new berthing infrastructure will begin by designating a work area at the port, adjacent to the jack-up barge which will be fenced off and made ready for the jack-up. The jack-up barge will be towed into the pile position where engineers will guide the barge into the correct location using surveying equipment. Once in position, the barge will jack down to give clearance above the high water. The new monopiles may be installed by two methods, either by rotary drilling or by top drive drilling if the sediments are too hard to use rotary drilling.

Once the monopile moorings have been installed the five pontoons will be fabricated on land, slipped into the water and towed into the final position where they will be tied on to the monopiles. Similarly, the brow access will be fabricated on land and lifted into position by a barge crane.

### 2.2.1 Rotary drilling methodology

1. A 1,800 mm casing will be lowered through the pile gate until the casing shoe reaches the seabed.
2. A RH34 drill rig will connect to the top of the casing using the drive adaptor.
3. The drill rig will progress the casing through the overburden into the rock to create a seal into the rock. The casing will prevent overburden falling into the open bore and ensure any disturbance caused by drilling is restricted to within the casing circumference.
4. The depth of casing penetration into the rock will depend on the degree of weathering and fissuring in the rock.
5. Once the casing is sufficiently sealed into the rock, the drill rig will open hole drill through the bottom of the casing and to the toe level, into the rock using augers and excavation buckets.
6. Drilling tooling will be connected to the Kelly bar to remove the spoil from within the casing and extract it directly into a muck skip on the deck of the jack up barge.
7. The borehole will be cleaned out using a cleaning bucket.
8. The 1,220 mm, circular hollow sections (CHS) pile complete with integral pre-welded and tested lifting points, spacer stools, base plate, two integral internal grout tubes, thermocouple as grout level indicator and capping plate flange will be lowered and accurately positioned in plan and importantly in verticality into the base of the borehole using the crane.
9. The pile will be partially filled with sea water to reduce its buoyancy.
10. Single size (40 mm) stone will be placed in the annulus between the casing and the pile up to rock head level. The 1,220mm pile is then locked into position.
11. Grout will be pumped through the grout tube(s) discharging through the base plate and into the void created under the base plate by the spacer stools.
12. Grouting will continue in a single operation filling the annulus between pile and casing to rock head level.
13. Grout level will be monitored by checking volumes used and checked with the thermocouple level.
14. The casing will be removed as soon as grouting is complete leaving the 1,220 mm CHS pile fixed in position.
15. The pile will be completely filled with sea water to avoid internal corrosion.
16. Once filled, the capping plate will be bolted into position on top of the pile.

### 2.2.2 Top drive drilling methodology

1. The pile gate will already be mounted over the side of the jack-up on the bull rail that allows it to move in the X and Y planes.

2. Once the pile gate is positioned over the confirmed pile location, the conductor, complete with its subsea gripper and casing shoe arrangement is lowered through the pile gate and held in position where alignment and verticality checks are then performed.
3. If penetration through self-weight is unsuccessful in achieving rock head, a vibro hammer may be used to facilitate casing shoe embedment.
4. The drill rig is then lifted and positioned on top of the conductor and captures the conductor inside the gripper can. The weight of the conductor and drill rig will allow the casing shoe to advance via self-weight penetration to rock head.
5. Once the casing shoe is at rock head, the drill string can be run in to mudline. This is done by lifting the Bottom Hole Assembly (BHA) from its horizontal storage position on the deck of the jack up, into the vertical and then loading it into the drill rig so it is hanging from the drill deck.
6. Depending on the depth to mudline, additional drill pipe will be added in a similar way to the BHA to increase the length of the overall drill string and touch down at mudline ready to start drilling.
7. The air compressor is started to initiate the airlift and flushing action that evacuates the drill cuttings from the socket at the face of the drill bit and rotation is started. Drilling of the socket then begins.
8. The drilling fluid (sea water only), and excavated material will be removed from the hole up the centre of the drill string and through the power swivel at the top of the drill rig and directed back into the sea adjacent to the drill rig through a 6m long spoil discharge hose.
9. As the hole progresses, further 3m long sections of drill pipe is added to the drill string to extend the length until target depth is reached.
10. At the end of the hole, the socket is flushed clean to remove any remaining sediments and the hole is dipped to check socket depth.
11. The drill pipe is then recovered from the string and returned to deck along with the BHA.
12. The drill rig is released from the conductor and too is lifted and placed back onto its stub support on deck.
13. Finally, the conductor releases the casing shoe and is lifted back onto deck via the rollover frame. The sacrificial casing shoe is left in place casing off the overburden above the open hole socket. The hole is now drilled, and the socket is ready for pile installation and grouting.
14. The pile is lifted from the quayside into the water where it will float due to the plates sealing it at both ends. It will then be towed and manoeuvred into position under the waiting hook of the crawler crane on the jack up.
15. The crane will be connected to the pile and the pile lifted out of the water and positioned over the pile gate and directly above the freshly drilled socket.
16. The pile will be lowered into the socket and water pumped into it via an inlet on the top plate which will sink it to the bottom of the socket.
17. Once on the socket floor and in final position, confirmed by survey, the pile will be secured in place ready for grouting operations to commence.
18. The grout will be delivered to the quayside in a standard mixer wagon and in a pumpable ready-mix form.
19. The grout is then pumped from the wagon into a skid mounted agitator on the deck of the Multi-cat support vessel and will then make its way out to the jack-up barge, tying up alongside.
20. The grout is then pumped through hoses across deck to connection points on the top plate of the pile. These are linked to steel pipework within the pile which delivers the grout down through the pile and discharges it through the base or side wall of the pile into the socket annulus.
21. One further transit of grout from the quayside will be required to provide the necessary volume for one pile location.
22. Once grout has reached initial set, the pile gate can be opened and tracked in board to release the pile from its support position.
23. Works are now complete on this pile and the jack-up barge is now ready to move to the next position.

## 3 EXISTING ENVIRONMENT

### 3.1 Overview

The baseline description provided below draws on information established in the original Environmental Appraisal report for the Band 2 Marine Licence application. Publicly available information sources were examined to inform the baseline characterisation for the purposes of the original Environmental Appraisal. These include:

- Publicly available environmental datasets and information including EUNIS habitat data, reports by Cefas on seabed habitats, fish spawning and nursery habitats; and
- Information from other marine users, including Pembroke Dock and the MHPA, licensed aggregate extraction and dredge disposal areas.

In addition, other publicly available information has been included where relevant.

### 3.2 Physical Processes

#### 3.2.1 Wave and tidal regime

The Milford Haven Waterway is approximately 35 km in length from its mouth, to source. The mean tidal range for the waterway varies from 6.3 m at Mean Springs tide to 2.7 m at Mean Neap tide.

Above the Cleddau Bridge, currents flow predominantly downstream in a southerly, then westerly direction to meet the main body of water in the Milford Haven where tidal processes determine current flows. The tidal excursion (the horizontal distance along the estuary that a particle moves during one tidal cycle of ebb and flood) varies along the length of the estuary and is approximately twice as great for springs as for neaps. Strong south-westerly winds, the prevailing wind direction for the Waterway, can cause noticeable variations in the heights and times of the tide. Tidal currents within the waterway are, however, much lower than along the open coast. The Waterway currents are higher within the main channel than within the embayment's and over the shallower intertidal areas adjacent to the main channel.

The tidal flow within the lower reaches of the Waterway can be generally summarised as flowing east up the Haven on the flood and west out of the Haven on the ebb. The maximum current flow is found in the middle of the main channel with a current velocity of up to 2.3 knots longitudinal to the META Phase 1 Site 3 - Ferryside. Minimum tidal flows occur around slack water (i.e., six hours before High Water (HW)) increasing to a maximum of 1.5 knots approximately three hours before HW on a spring tide with the tidal flow in an easterly direction. On neap tides, maximum tidal flows of up to 0.7 knots in a predominantly westerly direction, approximately 2.5 hours before HW.

Within the immediate vicinity of the META Phase 1 Site 3 - Ferryside, Carrs Rock and Hobbs Point are geological submerged bedrock features. These features deflect tidal currents flowing in a westerly direction downstream and forces the flow to the north side of the Waterway. As a result, these hydrodynamic and transport processes described above are deflected and dissipated, providing shelter in their lee. This leaves the META Phase 1 Site 3 - Ferryside in a relatively calm and low energy environment, suitable for testing renewable subassemblies/components.

#### 3.2.2 Suspended sediment concentrations

There is limited sediment input from offshore areas and the rivers that flow into the Waterway, with anthropogenic factors identified as the primary source of sediment disturbance. Suspended sediment concentrations are highly variable between seasons and influenced by freshwater input with high turbidity resulting from strong wave action and spring tides. The area experiences low turbidity during spring and summer due to weakened tidal streams, although particle concentration can increase due to blooms of phytoplankton in these seasons (Countryside Council for Wales, 2009).

Chronic sediment disturbance and re-suspension occurs due to the continual anthropogenic disturbance due to industrial activities throughout the waterway. Demolition of disused jetty structures, runoff from land disturbance, pile-driving during construction activities, propeller wash and bow-waves of tankers, tugs, ferries, cargo and fishing vessels have all been found to be sources of sediment re-suspension. In addition, a

major ongoing cause of anthropogenic sediment re-suspension within the waterway is likely to be periodic dredging as part of the capital and maintenance dredging operations by MHPA. Sediments re-suspended affect water transparency and therefore influence biotic processes.

Near the META Phase 1 Site 3 - Ferryside, the suspended sediment concentrations (SSC) as measured by the turbidity and water transparency were found to be dependent on biogenic and anthropogenic factors. RPS obtained turbidity data recorded in 2012 from Environmental Agency Wales (EAW) this data found that values ranged between a minimum of 2.3 formazin turbidity units (FTU) and a maximum of 19 FTU, with a mean value over the period of 9.5 FTU (EAW 2012). Turbidity peak values were recorded in spring, potentially coinciding with phytoplankton blooms, with lower values recorded during summer months potentially due to low rainfall and decreasing current speeds. Water transparency, determined by a Secchi disk, is dependent on particulate matter and dissolved substances in the water. Values recorded by EAW between 2009 and 2011 ranged from 1.2 m to 3.1 m.

### 3.2.3 Physical sediment conditions

Sediments associated with the META Phase 1 Site 3 - Ferryside comprise generally of mud and sand fractions. From four samples collected within two other META Phase 1 sites (Carr Jetty (site 1) and near to Mainstay Quay (site 2)), samples consisted 74% mud with sand fractions constituting the remaining 26%. These results are typical of the sediments found in low energy environments within the waterway which are characterised by low tidal currents and reduced wave action. A detailed analysis conducted by Carey *et al* (2014) also identified fine sediments as well as silt/clay to be the dominant sediment type.

## 3.3 Benthic Ecology

### 3.3.1 Subtidal ecology

The subtidal habitats of the Waterway are represented by mixed sediments, reef, and eelgrass beds. Oligochaetes, polychaetes, and amphipods characterise the mixed sediments with dominant species including *Paradoneis lyra*, *Pholoe synophthamica*, *Sphaerosyllis* spp. and the immigrant amphipod *Corophium sextonae*. Bivalves, such as the white furrow shell *Abra alba* are abundant towards the mouth of the Waterway. Subtidal reef habitat has a patchy distribution throughout the Waterway and is typically characterised by algae and bivalves on hard substrate, for example, the biotope red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles (SS.SMp.KSwSS.LsacR.CbPb) has been recorded for the Wales Habitats Features Map at reef habitat near the Cleddau bridge to the east of the META Phase 1 Site 3 - Ferryside (JNCC 2018). The reef building polychaete *Sabellaria spinulosa* has also been noted within the Waterway, and in undisturbed areas may form reef structures.

There are two populations of the subtidal seagrass *Zostera marina* within the Waterway, the largest of which lies 7 km to the west of Pembroke Dock, located in Littlewick Bay on the northern shoreline of the Waterway. The smaller population of *Z. marina* lies approximately 3 km to the north west of the Littlewick Bay population, near Great Castle Head in Longoar Bay. *Zostera marina* is typically found on sand to fine gravel in depths of up to 5 m.

Maerl beds are formed by slow-growing coralline algae and typically occur either on the open coast or in tide-swept channels of marine inlets. Maerl forms a unique habitat that supports a diverse assemblage of infauna and epifaunal species. A well-established maerl bed lies roughly 3 km to the west of the META Phase 1 Site 3 - Ferryside. This is the only known living maerl bed in Wales, excluding small amounts of maerl not constituting a bed. Maerl is legally protected under several designations including the EC Habitats Directive (92/43/EEC) as amended 2010 on the Conservation of Natural Habitats and of Wild Fauna and Flora, the UK Biodiversity Action Plan (BAP) for the diversity of flora and fauna (1994), and the Welsh Government's Habitats and Species of Principal Importance for Wales list. The maerl bed constitutes an Annex I Reef Habitat feature that is a primary reason for selection of the Pembrokeshire Marine/Sir Benfro Forol SAC.

The subtidal substrate near to the META Phase 1 Site 3 - Ferryside are mixed with varying proportions of silt/clay, fine sand, coarse sand and shells. In addition, cobble and rocky reef have been recorded roughly 200 m north of the META Phase 1 Site 3 - Ferryside. Subtidal benthic ecological communities in this area are characterised by annelids, bivalves, and green and brown algae. A review of data collected between 2008 to 2017 found that the most abundant species near to the META Phase 1 Site 3 - Ferryside were the

polychaetes *Melinna palmata* and Chaetozone gibber, seed shrimps *ostracoda* sp., and amphipods *Ampelisca diadema* and *Photis longicaudata* (Warwick, 2017).

## 3.4 Fish and Shellfish Ecology

### 3.4.1 Fish

The fish assemblages of the Waterway are typical of an estuarine environment with different characterising species towards the outer reaches of the estuary compared to the inner estuary reflecting the changes in environmental conditions, including substrate type, water flow and salinity. Gobies *Pomatoschistus* spp. are the most abundant species group with sand smelt *Atherina presbyter* and bass *Dicentrarchus labrax* also occurring in relatively high numbers. Three species of thick-lipped mullet were also regularly recorded within the Waterway. Otter trawls conducted for the Pembroke power station, approximately 2.5 km from Pembroke Dock Marine, recorded 19 species of fish including elasmobranchs, (thornback ray *Raja clavata*, lesser spotted dogfish *Scyliorhinus caniculus*), demersal flat fish (plaice *Pleuronectes platessa*) and abundant gobies.

Several species of diadromous fish migrate through the estuary between seawater and freshwater, all of which are of conservation importance as Annex II species protected under European legislation or as Welsh BAP priority species. Four of the species of diadromous fish are qualifying interest features of the Pembrokeshire Marine/Sir Benfro Forol SAC: sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa* and twaite shad *Alosa fallax*. River and sea lamprey are also qualifying interest features of the Cleddau Rivers/Afonydd Cleddau SAC. Atlantic salmon *Salmo salar*, sea trout *Salmo trutta* and European eel *Anguilla anguilla* are all listed as OSPAR threatened/declining species and are listed as Welsh BAP priority species.

The waterway provides a suitable spawning habitat for sandeel *Ammodytes americanus*, plaice *Pleuronectes platessa*, and sole *Solea vulgaris* (Ellis *et al.*, 2012). The sheltered estuarine conditions also provide a safe environment for juvenile fish and therefore the waters of the Waterway are mapped as an important nursery area for sandeel, plaice, sole, whiting, herring, mackerel, spotted ray, thornback ray and tope shark (Ellis *et al.*, 2012).

### 3.4.2 Shellfish

The diverse intertidal and subtidal sediment types within the Waterway provide suitable habitats for a range of shellfish species. These include the native oyster *Ostrea edulis*, edible mussels *Mytilus edulis*, lobsters *Homarus gammus*, and prawn *Palaemon serratus*, some of which have conservation and commercial interests. Due to the specificity and sensitivity, the native oyster has been classified as a threatened species and is covered by a UK BAP. The species is of principal importance for conservation of biodiversity under the NERC Act 2006 and is on the OSPAR list of threatened and/or declining species. However, native oysters are widespread throughout the Waterway with stocks present from Milford Haven town up to Picton Point (Hobbs and Morgan, 1992).

## 3.5 Marine Mammals

### 3.5.1 Cetaceans

Of the 18 species of cetaceans found within Welsh coastal and offshore waters, only harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus* are known to occur within the Waterway. Most individuals are likely to occur within the lower reaches of the estuary with very few venturing as far up as the META Phase 1 Site 3 - Ferryside (Baines and Evans 2012; Reid *et al.*, 2003; Hammond *et al.*, 2017).

Harbour porpoise is widespread and abundant throughout British waters and the most recent SCANS (Small Cetacean Abundance in the North Sea) surveys estimated the population in the Celtic/Irish Sea Management Unit at 26,700 animals, with a density estimate of 0.118 for SCANS-III Block D (coinciding with the Waterway) (Hammond *et al.*, 2021). Locally, high densities of harbour porpoise are known from coastal waters off southwest Wales (Reid *et al.*, 2003), and are particularly abundant around the Pembrokeshire Islands (De Boer and Simmonds, 2003). Harbour porpoise are found in water depths of 3 m to 100 m but normally less than 50 m, and are often observed in coastal waters, particularly during the summer months (Shepherd and Rowson, 2006). As a species with a high metabolic rate, they need to feed regularly, and key

prey items include schooling gadoids (Read, 1999) such as pollack, cod, poor cod *Trisopterus minutus*, whiting and hake, and inshore shoaling fish such as herring, sandeel, sprat, mackerel, squid, octopus and crustaceans (Hutchinson *et al.*, 1995).

Bottlenose dolphin occurs regularly within Welsh waters with most sightings around Cardigan Bay, where there is a resident population (Baines and Evans, 2012). There are frequent sightings elsewhere along the Pembrokeshire coast, particularly off Skokholm and Skomer and sometimes off Strumble Head, especially between July and September (Baines and Evans, 2012). During the most recent SCANS-III surveys, 2,938 bottlenose dolphins were estimated within SCANS-III survey Block D (coinciding with the Waterway), with an estimated density of 0.06 animals per km<sup>2</sup> (Hammond *et al.*, 2021). Bottlenose dolphins are typically found within 10 miles of the coast and often occur in large groups of up to 60 individuals near to Cardigan Bay (Baines and Evans, 2012).

### 3.5.2 Pinnipeds

Only one species of pinniped, grey seal *Halichoerus grypus*, occurs in Welsh waters. The Pembrokeshire coast contains the primary colony in Wales and is the most southerly in Europe of any significant size (Baines *et al.*, 1995). Grey seals haul out to rest, pup, and nurse their young. Moulting and resting haul-out sites are distributed throughout the Pembrokeshire Marine/Sir Benfro Forol SAC. Pupping also takes place throughout the Pembrokeshire Marine/Sir Benfro Forol SAC on open coasts where suitable habitat is present (i.e., physically accessible to grey seals, remote and/or undisturbed rocky coast beaches, coves, and caves). The most recent estimates for pup production at the major haul-outs in Wales are 465 pups in North Pembrokeshire in 2005 (Strong *et al.*, 2006) and 243 pups born on Skomer island in 2020 (NRW, 2020). A NRW report from 2017 suggest that the grey seal population of Marloes peninsula, east of Skomer Island, is growing at a rate of 6% per year (Bull *et al.*, 2017). It is estimated 4% of the world's grey seals breed in Wales (Duck 2009). Historic data suggests that grey seals may occasionally occur in low numbers within the Waterway and near to the META Phase 1 Site 3 - Ferryside.

Grey seals are highly mobile, and forage widely, frequently travelling up to 100 km between their haul-out sites and foraging areas, though they can travel further (SCOS, 2017). As generalist feeders, grey seals feed on a wide range of prey items including whiting, cod, haddock, ling, and various species of flatfish. A study of grey seal diets from scats collected in Pembrokeshire, found that gadoids (mainly whiting) and flatfish (mainly sole) dominated the diet (Strong, 1996).

### 3.5.3 Otters

Otters utilise freshwater, brackish, and marine environments and are known to occur in Welsh coastal waters (NTW, 2018; Strachan, 2015). The otter has a wide range and distribution throughout Pembrokeshire coastal waters, including within the Waterway (known from spraint records and foreshore access points from watercourses with suitable breeding and feeding habitat; Liles, 2003). With a varied diet, spraints collected from the open coast of Pembrokeshire and within the Waterway were analysed and found to contain remains of many different species of marine, estuarine, and saltwater fish.

Due to the wide distribution and range of otter activity recorded within the Waterway it is likely that this species occurs near the META Phase 1 Site 3 - Ferryside (Liles, 2003). Otter is an Annex II species present as a qualifying interest feature of the Pembrokeshire Marine/Sir Benfro Forol SAC, as well as being listed under Schedule 5 of the Wildlife and Countryside Act 1981. Otters is also a qualifying feature of the Cleddau Rivers/Afonydd Cleddau SAC. The Cleddau Rivers may represent a source population in which despotic displacement may lead to otters venturing further into the marine environment. However, the marine environment may not represent a preferential habitat for breeding as the otter is primarily a freshwater/terrestrial species.

### 3.6 Shipping and Navigation

Pembroke Dock handles up to 62,000 Ro-Ro<sup>1</sup> units per year. The Pembroke Dock ferries arrive and depart from the Dock on their way to or back from their proposed destination. Operational activities associated with Pembroke Dock include mooring and transiting of tugs, service and pilot vessels, renewables support, with occasional dredging operations carried out as part of port maintenance and commercial development. All vessel pilotage is closely controlled by the MHPA (MHPA, 2016).

### 3.7 Designated Sites

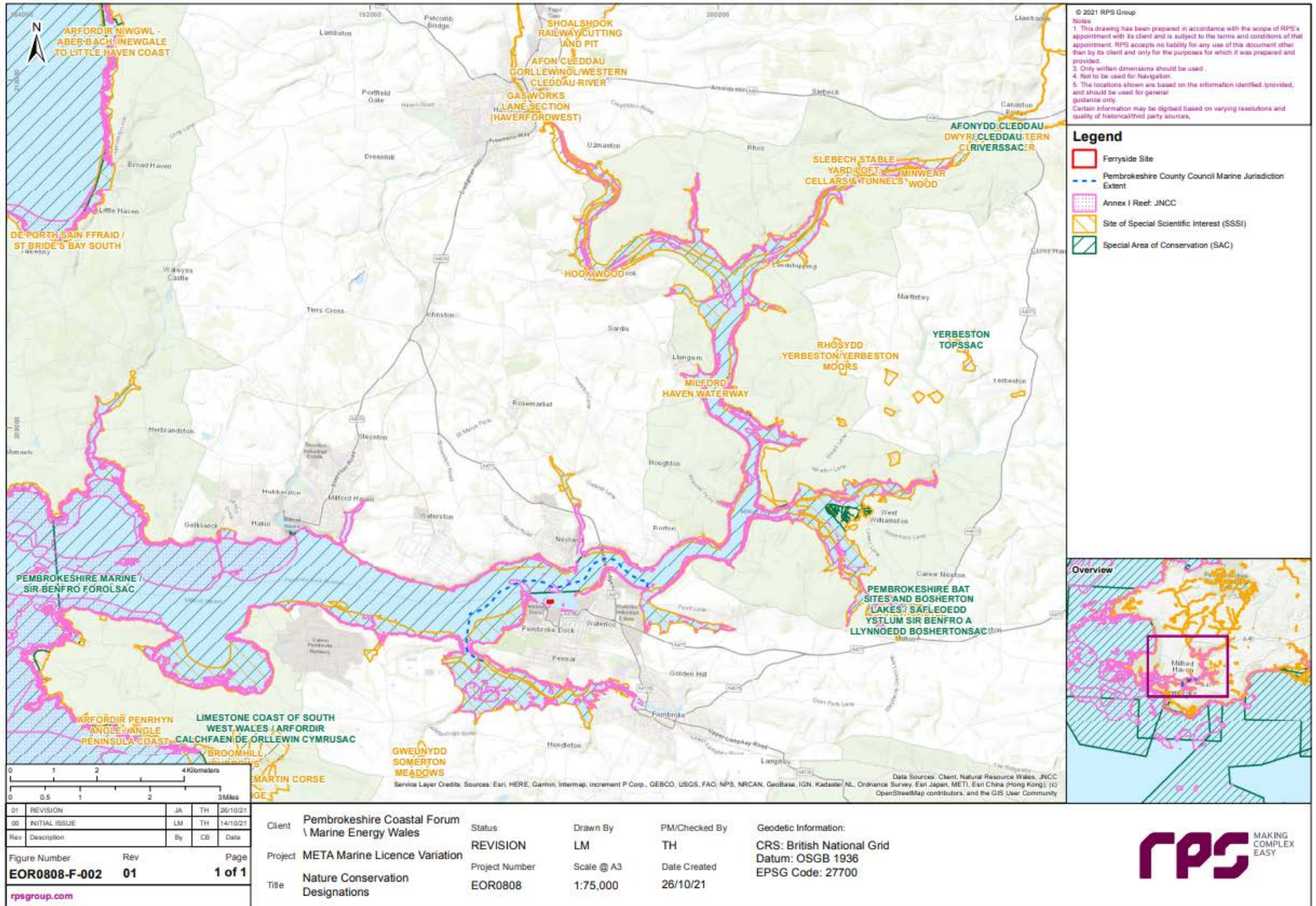
The META Phase 1 Site 3 - Ferryside lies outside any international, national or local environmentally designated sites. Designated sites located near, or which have qualifying interest features that could be affected by, the proposed activities at the META Phase 1 Site 3 - Ferryside include (Figure 3.1):

- Pembrokeshire Marine/Sir Benfro Forol SAC;
- Cleddau Rivers/Afonydd Cleddau SAC;
- West Wales Marine/Gorllewin Cymru Forol SAC; and
- Milford Haven Waterway Site of Special Scientific Interest (SSSI).

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<sup>1</sup> Roll-on/roll-off units - vessels designed to carry wheeled cargo, such as cars, trucks, semi-trailer trucks, trailers, and railroad cars, that are driven on and off the ship on their own wheels.

# META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL



**Table 3.1: Designated sites near the META Phase 1 Site 3 - Ferryside (features not applicable to this assessment are greyed out)**

Designated site	Distance from the META Phase 1 Site 3 - Ferryside	Relevant Qualifying Interest Features	Conservation Objectives
Pembrokeshire Marine/ Sir Benfro Forol SAC	~150 m north	<ul style="list-style-type: none"> <li>• Large shallow inlets and bays</li> <li>• Estuaries</li> <li>• Reefs</li> <li>• Mudflats and sandflats not covered by seawater at low tide</li> <li>• Sandbanks which are slightly covered by sea water all the time</li> <li>• Coastal lagoons</li> <li>• Atlantic salt meadows (<i>Glauco-Puccinellietalia maritimae</i>)</li> <li>• Submerged or partially submerged sea caves</li> <li>• Grey seal <i>Halichoerus grypus</i></li> <li>• Mobile fish species:                             <ul style="list-style-type: none"> <li>– Sea lamprey <i>Petromyzon marinus</i></li> <li>– River lamprey <i>Lampetra fluviatilis</i></li> <li>– Allis shad <i>Alosa alosa</i></li> <li>– Twaite shad <i>Alosa fallax</i></li> </ul> </li> <li>• Otter <i>Lutra lutra</i></li> <li>• Shore dock <i>Rumex rupestris</i></li> </ul>	<ul style="list-style-type: none"> <li>• To meet the aims of the Habitats Directive, the conservation objectives seek to maintain (or restore) the habitat and species features, as a whole, at (or to) favourable conservation status (FCS) within the site.</li> <li>• In order to achieve FCS all of the following, subject to natural processes, need to be fulfilled and maintained in the long-term. If these objectives are not met restoration measures will be needed to achieve FCS:                             <ul style="list-style-type: none"> <li>– Range - the overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing;</li> <li>– Structure and function - the physical biological and chemical structure and functions necessary for the long-term maintenance and quality of the habitat are not degraded; and</li> <li>– Typical species - the presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded.</li> </ul> </li> <li>• To ensure for qualifying features (species population) that, subject to natural change, the following attributes are maintained or restored in the long term:                             <ul style="list-style-type: none"> <li>– The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include: population size; structure, production; and condition of the species within the site;</li> <li>– The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future; and</li> <li>– The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and population dynamics of the species within the site and population beyond the site is stable or increasing.</li> </ul> </li> </ul>
Cleddau Rivers/Afonydd Cleddau SAC	11 km north	<ul style="list-style-type: none"> <li>• Mobile fish species:                             <ul style="list-style-type: none"> <li>– River lamprey <i>Lampetra fluviatilis</i></li> <li>– Sea lamprey <i>Petromyzon marinus</i></li> <li>– Bullhead <i>Cottus gobio</i></li> <li>– Brook lamprey <i>Lampetra planeri</i></li> </ul> </li> <li>• Otter <i>Lutra lutra</i></li> <li>• Habitats:</li> </ul>	<ul style="list-style-type: none"> <li>• To avoid deterioration of the habitats of the qualifying features or significant disturbance to the qualifying features, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to maintaining FCS for the qualifying features.</li> <li>• To ensure for qualifying features that, subject to natural change, the following attributes are maintained or restored in the long term:                             <ul style="list-style-type: none"> <li>– The species is a viable component of the site;</li> <li>– There is no significant disturbance of the species; and</li> </ul> </li> </ul>

Designated site	Distance from the META Phase 1 Site 3 - Ferryside	Relevant Qualifying Interest Features	Conservation Objectives
		<ul style="list-style-type: none"> <li>- Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and Callitricho-Batrachion vegetation</li> <li>- Active raised bogs</li> <li>- Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (<i>Alnion incanae</i>, <i>Salicion albae</i>). Alno-Padion (Forest type as described by European Environment Agency)</li> </ul>	<ul style="list-style-type: none"> <li>- The supporting habitats and processes relevant to qualifying features and their prey are maintained.</li> </ul>
West Wales Marine/Gorllewin Cymru Forol SAC	11 km west	<ul style="list-style-type: none"> <li>• Harbour porpoise <i>Phocoena phocoena</i></li> </ul>	<ul style="list-style-type: none"> <li>• To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters</li> <li>• In the context of natural change, this will be achieved by ensuring that:                             <ul style="list-style-type: none"> <li>- Harbour porpoise is a viable component of the site;</li> <li>- There is no significant disturbance of the species; and</li> <li>- The condition of supporting habitats and processes, and the availability of prey is maintained.</li> </ul> </li> </ul>
Milford Haven Waterway SSSI	<50 m	Intertidal rocky shore, sandflats, mudflats	<ul style="list-style-type: none"> <li>• N/A</li> </ul>

## 4 MEASURES ADOPTED AS PART OF THE PROJECT

There are several mitigation measures that have been adopted as part of the META Phase 1 project and were committed to as part of the awarded marine licence. These measures are listed in Table 4.1 and referred to in the individual assessments where relevant.

**Table 4.1: Mitigation measures adopted as part of the META Phase 1 project**

Measure	Description
<b>Communications/ Awareness</b>	
Notices to Mariners	The Applicant will issue Notices to Mariners advising of the nature, location and timing of the works to the MHPA, who will promulgate this information to other sea users.
Navigation Safety Requirements	All vessel movement within the Waterway is closely controlled by the MHPA, and restricted due to deep water channels. MHPA has released a guidance document for all vessels that enter the Waterway; to follow procedure for docking at all ports (MHPA General Direction, 2016). However, for the META project, consultation and ongoing liaison will be carried out with the MHPA to determine vessel procedures for operations within Pembroke Dock.
HM Coastguard	The Applicant will ensure that HM Coastguard, in this case nmoccontroller@hmcg.gov.uk, The National Maritime Operations Centre is made aware of the works prior to commencement.
<b>Marine Pollution/ Safety</b>	
Marine Pollution Contingency Plan	The Applicant will ensure pollution prevention control measures are implemented as standard. The META Marine Pollution Contingency Plan, which has been drafted and submitted to NRW for approval, PCF covering both the META Phase 1 sites and the META Phase 2 sites, clearly sets out response procedures in the unlikely event of a spill, including the communications and reporting procedures in the event of an oil or chemical spill, checklists, and reporting proformas, a risk assessment and environmental sensitivities map, and background information on oil spill dispersion. Any incidents will be reported to Natural Resources Wales using their hotline number 0300 065 3000 at the earliest possible date.
Vessel Management Plan	All vessels will be approved for operation on site by the Applicant, with appropriate certification and inspections if required, carried out prior to commencement of the operation. Vessel contractors will be required to supply all necessary certificates and permits to the Applicant, including an up to date Common Marine Inspection Document report. The Applicant will require that all vessels are equipped with spill trays and a Shipboard Oil Spill Emergency Plan kit. Each vessel will be required to implement a Safety Management System.
Bunding and storage	The Applicant will ensure bunding and storage facilities are installed to contain and prevent the release of fuel, oils and chemicals associated with the plant, refuelling and construction equipment into the marine environment.
Refuelling	Plant, vehicles and machinery will not be refuelled on the foreshore.
<b>Environment</b>	
Biosecurity Action Plan	The existing META Phase 1 Marine Licence requires the Licence Holder to produce and implement a Biosecurity Action Plan. An Invasive Non-native Species Management Plan (INNSMP) covering both the META Phase 1 and Phase 2 sites has been which has been drafted by PCF and submitted to NRW for approval. The INNSMP will be available for inspection at all reasonable times.
Equipment Removal	All equipment, temporary structures, access tracks, waste and/or debris associated with the works will be removed within 4 weeks of completion of the works.
Paints and coatings	All coatings/treatments used will be suitable for use in the marine environment and are used in accordance with best environmental practice.

## 5 ASSESSMENT OF EFFECTS

### 5.1 Approach

A scoping exercise was carried out to inform this environmental appraisal, based on RPS's extensive experience in preparing similar assessments for comparable licensable activities. The following sections provide an assessment of the potential environmental impacts of the increase in pontoon size and associated pile installation in relation to the following environmental topics:

- Physical Processes;
- Benthic Ecology;
- Fish and Shellfish;
- Marine Mammals; and
- Shipping and Navigation

Activities, topics, and impacts scoped out of the assessment are presented in together with justification in Appendix A.

The assessment presented in this section considers the maximum scenario for the META Phase 1 Site 3 - Ferryside installation of monopiles and larger pontoons (hereafter referred to as the 'licensable activities') as presented in Section 2, however this is considered likely to result in a highly precautionary impact assessment. The most likely impact is likely to be less than that predicted as part of the assessment. Each potential impact is assessed based on the META Phase 1 Site 3 - Ferryside licensable activities (Table 2.1).

Potential impacts in relation to each of the environmental topics identified have been assessed using the author's experience gained through previous work on the META Phase 1 and Phase 2 projects as well as undertaking assessments for similar projects within the UK, including the Pembroke Dock Infrastructure project. Each assessment concludes whether the licensable activities are likely to result in a negligible, minor, moderate, or major effect on the receptor. For the purpose of this assessment the following has been assumed:

- **Negligible** effects are those that are not considered to be detectable above natural variation;
- **Minor** effects are those that may be detectable above natural variation but are not considered likely to affect receptors in the medium term (months).
- **Moderate** effects are those that may affect receptors in the medium to long-term (months - years);
- **Major** effects are those that may affect receptors in the long term (years).

Consideration of the potential for Likely Significant Effect (LSE – as defined by the Habitats Regulations 2017) on the National site network sites is presented in Section 7 and an assessment against the Water Framework Directive is presented in Section 7.1.3.

### 5.2 Physical Processes

#### 5.2.1 Increases in suspended sediment concentrations from vessel movements

Increases in suspended sediment concentrations (SSC) may occur as a result of the action of propellers and dynamic positioning of the vessels used to install the new monopiles and pontoon at the META Phase 1 Site 3 - Ferryside disturbing and mobilising soft sediments. Up to 10 vessels may be on site at any one time to install the monopiles and pontoons. The additional ten vessels will be an increase from the number of licenced vessels however it represents a very small increase from the number of vessels that use Pembroke Dock every day. Furthermore, the uplift will only be temporary (up to 60 days) and short term.

Sediment plumes generated from propeller wash are likely to be a daily occurrence within Pembroke Dock as part of operational vessel movements associated with port operations. Vessel movements associated with the META Phase 1 Site 3 - Ferryside licensable activities may cause localised, short term and reversible increases in SSC, however it is unlikely that any increases in SSC will be detectable above baseline

conditions including existing port operations. Therefore, the effect of the licensable activities on suspended sediment concentration is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

### 5.2.2 Changes to wave conditions from pontoon installation

The pontoons will be installed on the south side of the existing Pembroke Dock Ferry Terminal Ro-Ro Berth, along the northern edge of the META Phase 1 Site 3 - Ferryside. Each of the pontoons will cover an area of 5 m x 25 m (125 m<sup>2</sup> area each) and there will be five pontoons covering a total area of 625 m<sup>2</sup>. The pontoons will be tethered to ten new 1,220 mm monopiles and will float on the water surface. The pontoons and monopiles will be built on the lee side of the existing Ro-Ro berth where wave energy will already be dissipated by existing dolphins and the presence of moored vessels. Furthermore, wave conditions at the META Phase 1 Site 3 - Ferryside are already influenced by existing infrastructure, such as a pier west of the site and ferry docking stations further along the dock making the potential impact of the monopiles highly localised. Therefore, the effect of the licensable activities on wave conditions is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

## 5.3 Benthic Ecology

### 5.3.1 Habitat disturbance/loss associated with monopile and pontoon installation

Long term habitat loss will occur within the footprint of the ten new monopiles which will be installed to support the pontoons. Each monopile will have a seabed footprint of 1.16 m<sup>2</sup> with a total seabed footprint of 11.6 m<sup>2</sup>. This area is very small in the context of the wider Waterway.

Temporary habitat loss may also occur within the META Phase 1 Site 3 - Ferryside as a result of installation of the pontoon monopiles and associated jack up vessel events. As described in Section 2, ten monopiles will be installed using rotary drilling or top drive drilling methodologies to ensure a secure mooring for the five new pontoons. Two jack-up events will be required for each monopile installation and three required for the walkway installation, resulting in 112.24 m<sup>2</sup> of temporary habitat loss/disturbance as a result of jack up events (4.88 m<sup>2</sup> per jack-up).

The 1,800 mm diameter monopile casings are larger than the 1,220 mm monopiles and will be removed once the monopiles are installed, therefore an additional 1.38 m<sup>2</sup> of seabed per pile may be subject to temporary habitat disturbance during monopile installation. As described in Section 2.2, grout will be pumped into the foundation of the monopile. There is potential for a small amount of the grout to spill out of the foundation and onto the surrounding seabed. This will be an accidental event therefore it is impossible to quantify the area of seabed which may be affected however it is likely to be minimal.

Overall, the potential area of habitat disturbance/loss will be approximately 137.64 m<sup>2</sup>. This is roughly equivalent to the area of one anchor deployment (144 m<sup>2</sup>) as assessed in the original Marine Licence application. The original Marine Licence application assessed a disturbance area of 656.5 m<sup>2</sup> per site at the META Phase 1 Site 3 - Ferryside as up to two devices are expected to be installed, in addition to anchor placements. Therefore, the proposed increase of 137.64 m<sup>2</sup> represents a very small increase in habitat disturbance from what is licenced.

Temporary habitat disturbance around the monopiles will be short term, localised, and reversible. The benthos at the META Phase 1 Site 3 - Ferryside and the wider waterway are regularly disturbed by the operational activities which take place at the neighbouring Pembroke Docks including anchoring and propeller action by third party vessels.

The META Phase 1 Site 3 - Ferryside is dominated by sand and mud sediments, as well as silt/clay, colonised by annelids and bivalves. The sensitivity of this sand and mud habitat to penetration and disturbance is low. Characterising species comprise burrowing species which can better avoid the effects of penetration disturbance and highly mobile swimmers which are adapted to life in unstable sediments (Tillin *et al.*, 2019a,b; Tillin and Budd, 2016; Tillin and Rayment, 2016). Characteristic mobile species such as *Hediste divrsicolor* are likely to recover quickly to recolonise the area (Lewis *et al.*, 2012). Disturbance may damage

the proportion of sessile bivalve molluscs however they are like to recruit and recover rapidly as the area disturbed is very small compared to the surrounding habitat.

Coarse sediment habitats at the META Phase 1 Site 3 - Ferryside (Warwick, 2017) are not sensitive or have low sensitivity to disturbance and penetration. Characterising species are robust and mobile and can therefore avoid disturbance by swimming (Tillin, 2016a). Burrowing bivalves would also be unaffected by surface abrasion however venerid bivalves which live close to the surface are more likely to be damaged. Trawling studies on coarse sediments have suggested that the characterising species are relatively tolerate to disturbance and penetration (Tillin, 2016b; Capasso *et al*, 2010).

Sand, mud and coarse sediment habitat communities have high sensitivity to substrate change as the change to artificial substratum (monopile) would alter the character of the habitat (Tillin *et al.*, 2019a,b; Tillin and Budd, 2016; Tillin, 2016; Tillin, 2016b; Tillin and Rayment, 2016). The small area (11.6 m<sup>2</sup>) impacted by this change however means these habitats are unlikely to experience population scale change.

Rocky reef has been recorded roughly 200 m beyond the boundary of the META Phase 1 Site 3 - Ferryside (JNCC, 2019). The licensable activities will not extend beyond the existing dolphins at the META Phase 1 Site 3 – Ferryside. Therefore, there will be no direct impact on the rocky reef.

Therefore, the effect of licensable activities on benthic habitat loss/disturbance is considered to be **minor**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

### 5.3.2 Increases in suspended sediment concentrations

Increases in SSC may occur as a result of the action of propellers and dynamic positioning of the vessels used to install the new monopiles and pontoon at the META Phase 1 Site 3 - Ferryside disturbing and mobilising soft sediments. Up to 10 vessels may be on site at any one time to install the monopiles and pontoons. As described under section 5.2 above, any increases in suspended sediment concentrations will be localised, short term and reversible, however it is unlikely that any increases in SSC will be detectable above baseline conditions including existing port operations.

Sand, mud and coarse sediments habitats have low sensitivity to increases in SSC, characterising species live within the sand and are unlikely to be directly affected by an increased concentration of suspended matter in the water column. The characterizing, suspension feeding bivalves are likely to regularly exposed to, and tolerant of, short-term increases in SSC (Tillin and Garrard, 2019b; Tillin & Rayment, 2016; Tillin, 2016b)

Rocky reef has been recorded roughly 200 m beyond the boundary of the META Phase 1 Site 3 - Ferryside (JNCC, 2019) which has the potential to be impacted should the habitat disturbance cause any suspended sediments to travel. Some small species such as *Psammechinus miliaris* which have been recorded in infralittoral rocky reef communities can be adversely affected by as much as 5 cm of sediment, overall making these communities moderately sensitive to light smothering and siltation rate changes (Stamp, 2021). Due to the location of this reef, adjacent to Pembroke Docks, the pontoon installation is unlikely to increase suspended sediment beyond baseline level, which local communities will be accustomed to.

Therefore, the effect of licensable activities on benthic receptor as a result of an increased in SSC is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 Marine Licece assessment.

## 5.4 Fish and Shellfish Ecology

### 5.4.1 Underwater noise effects from monopile installation

Underwater noise has the potential to affect fish in different ways depending on the noise level and characteristics. The activities related to the installation of the ten new monopiles may result in the generation of non-impulsive (continuous) sound. Non-impulsive sound is typical of continuous running machinery, and vessels. If the frequency of non-impulsive noise emissions overlaps with the frequencies audible by fish, this may influence the animal (Weilgart, 2007). The level of influence varies with distance from the source and level.

For this project two methods of pile installation are proposed to ensure drilling can occur despite any potential geological constraints or equipment shortages. These sound sources were modelled to understand their impact on the relevant fish (the full noise report can be found in Appendix C). The preferred method for

pile installation is rotary drilling and the source sound levels used for the underwater noise assessment have been based on pile drilling for the Oyster 800 project (Kongsberg, 2011). Top drive drilling methods may be used where harder ground is encountered. The source levels used in the underwater noise assessed were based on pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford lough (Nedwell and Brooker 2008). The source levels used in the assessment are summarised in Table 5.1.

**Table 5.1: Noise source levels used in assessment (un-weighted).**

Parameter	Source level at 1 m
<b>Rotary Drilling</b>	
SEL per second of operation @ 1 m, dB re 1 $\mu\text{Pa}^2\text{s}$	163
Peak sound pressure level @ 1 m, dB re 1 $\mu\text{Pa}$	166
rms <sub>T90</sub> sound pressure level @ 1 m, dB re 1 $\mu\text{Pa}$	163
<b>Top drive drilling</b>	
SEL per pulse @ 1 m, dB re 1 $\mu\text{Pa}^2\text{s}$	162
Peak sound pressure level @ 1 m, dB re 1 $\mu\text{Pa}$	165
rms <sub>T90</sub> sound pressure level @ 1 m, dB re 1 $\mu\text{Pa}$	162

For fish, the most relevant criteria for injury from sound are considered to be those contained in the recent Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.* 2014). These guidelines do not group by species but instead broadly group fish into the following categories based on their anatomy and the available information on hearing of other fish species with comparable anatomies:

- **Group 1 fish:** fishes with no swim bladder or other gas chamber (e.g., elasmobranchs, flatfishes, and lampreys). These species are less susceptible to barotrauma and are only sensitive to particle motion, not sound pressure;
- **Group 2 fish:** fishes with swim bladders but the swim bladder does not play a role in hearing (e.g., salmonids). These species are susceptible to barotrauma, although hearing only involves particle motion, not sound pressure;
- **Group 3:** Fishes with swim bladders that are close, but not connected, to the ear (e.g., gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than groups 1 and 2, extending to about 500 Hz;
- **Group 4:** Fishes that have special structures mechanically linking the swim bladder to the ear (e.g., clupeids such as herring, sprat and shads). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3;
- **Sea Turtles:** There is limited information on auditory criteria for sea turtles and the effect of impulsive noise is therefore inferred from documented effects to other vertebrates. Bone conducted hearing is the most likely mechanism for auditory reception in sea turtles and, since high frequencies are attenuated by bone, the range of hearing are limited to low frequencies only (Tonndorf, 1972). For leatherback turtle the hearing range has been recorded as between 50 and 1,200 Hz with maximum sensitivity between 100 and 400 Hz (Piniak *et al.*, 2012); and
- Fish eggs and larvae.

The guidelines set out criteria for injury due to different sources of noise. The criteria include a range of indices such as the Sound Exposure Level (SEL, the total sound energy of an event normalised to 1 second), and peak sound pressure levels (SPL, the difference between the highest-pressure variation and the mean pressure). Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e., in the tens of metres), “intermediate” (i.e., in the hundreds of metres) or “far” (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different noise levels

and therefore all sources of noise, no matter how noisy, would theoretically elicit the same assessment result. To establish the temporary threshold shift (TTS) (when noise is great enough to cause temporary damage to the ear tissue) the following criteria (Popper *et al.*, 2014) were used:

- For continuous sound it is 158 dB re 1 µPa (rms) for 12 hours.

Based on the existing environmental information Allis shad and Twaite shad which are qualifying features of the Pembrokeshire Marine/ Sir Benfro Forol SAC, as well as European eels have been identified as group 3 and 4 species. Atlantic salmon are also found in this area and are identified as a group 2 fish. Furthermore, sea lamprey and river lamprey - which are qualifying features of the Pembrokeshire Marine/ Sir Benfro Forol SAC - are group 1 fish as well as sand eel, sole and plaice but are of least concern in terms of underwater noise.

The criteria used in this noise assessment for rotary and top drive drilling (non-impulsive) are given in Table 5.3.

**Table 5.2: Criteria for onset of injury to fish due to non-impulsive sound (Popper *et al.*, 2014).**

Receptor	Mortality and potential Recoverable Injury mortal injury		TTS
Group 1 Fish – including sea lamprey, river lamprey, sand eel, plaice, sole and mackerel	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Group 2 Fish – including Atlantic salmon	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Groups 3 and 4 Fish – including Twaite shad, Allis shad, European eel, and herring	(Near) Low (Intermediate) Low (Far) Low	170 dB re 1 µPa (rms) for 48 hours	158 dB re 1 µPa (rms) for 12 hours

Behavioural reaction of fish to sound has been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish’s body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders. Highly sensitive species such as herring and Allis shad have elaborate specialisations of their auditory apparatus, known as an otic bulla – a gas-filled sphere, connected to the swim bladder, which enhances hearing ability. The most recent criteria for disturbance are considered to be those contained in Popper *et al.* (2014) which set out criteria for disturbance due to different sources of noise (Table 5.3).

**Table 5.3: Criteria for onset of behavioural effects to fish due to non-impulsive sound (Popper *et al.*, 2014).**

Receptor	Relative risk of behavioural effects
Group 1 Fish – including sea lamprey, river lamprey, sand eel, plaice, sole and mackerel	(Near) Moderate (Intermediate) Moderate (Far) Low
Group 2 Fish – including Atlantic salmon	(Near) Moderate (Intermediate) Moderate (Far) Low
Groups 3 and 4 Fish – including Twaite shad, Allis shad, European eel, and herring	(Near) High (Intermediate) Moderate (Far) Low

It is important to note that the Popper *et al.* (2014) criteria for disturbance due to sound are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. drilling) would result in the same predicted impact, no matter the level of noise produced or the propagation characteristics.

The underwater noise model predicted that, for both non-impulsive method, there is no risk of mortality or recoverable injury (injury that can lead to death if they decrease the animal's fitness (Hawkins and Popper, 2014)) or TTS in any fish (Table 5.4). Pile installation is expected to occur intermittently over a period of up to 60 days. Each pile is expected to take up to 1 hour to install, resulting in 10 hours of installation in total.

**Table 5.4: Summary of potential injury and disturbance zones for both (rotary drilled and top drive drilled) pile installation methods (N/E – not exceeded)**

Receptor	Pile Installation Method	Mortality / potential mortal injury	Recoverable Injury TTS	
Groups 1 and 2 Fish	Rotary drilling	No threshold	No threshold	No threshold
	Top drive drilling		No threshold	No threshold
Groups 3 and 4 Fish	Rotary drilling		N/E	N/E
	Top drive drilling		N/E	N/E

The impact of underwater noise on the behaviour of fish is highly dependent on their proximity to the noise source. Table 5.3 highlights that Twaite and Allis shad and the other group 3 and 4 fish have high risk of behaviour change in the near field (10's of meters) should either drilling method be used. The boundary of the nearest SAC which is designated for both shad is approximately 150 m away, making the potential impacts from noise on the features of the SAC minimal. The risk is moderate at intermediate distances for both shad species however the background noise of Pembroke Dock has the potential to deter the shad from entering this site preventing them from experiencing the levels of noise required for behavioural effects as a result of pile installation. Only groups 3 and 4 fish are at high risk of behaviour change in the near field.

Adult fish not in the immediate vicinity of the pile installation works are generally able to vacate the area and avoid physical injury. Furthermore, the installation site sits within the highly active Pembroke Dock which produces underwater noise from vessels on a daily basis. Noise sensitive fish are therefore unlikely to frequent this area. The additional vessels need for the installation of the monopiles is unlikely to exceed the background noise levels of the port.

Therefore, the effect of underwater noise from licensable activities on fish and shellfish is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase1 Marine Licence assessment.

### 5.4.2 Temporary habitat disturbance associated with pontoon installation

Temporary habitat disturbance of 137.64 m<sup>2</sup> may occur within the META Phase 1 Site 3 - Ferryside as a result of installation of the pontoon monopiles and associated jack up vessel events, as described in Section 5.3.1. This also has potential to cause indirect effects on fish and shellfish receptors by removing habitat in which they rely on. The 137.64 m<sup>2</sup> of temporary habitat disturbance would be short term, highly localised, reversible and would represent a very small portion of the habitat available to mobile fish in this area. The licensable activity on the META Phase 1 Site 3 - Ferryside may temporarily change the behaviour of fish, causing them to avoid the site during installation however they are likely to return when activity returns to baseline levels. The impact on shellfish has the potential to be greater due to their sessile nature, potentially resulting in fatalities, however as the area disturbed is very small recovery is likely to occur relatively quickly. The Waterway also contains fish spawning grounds for a number of species (Section 3.4.1), however due to the active nature of neighbouring Pembroke Docks the area around the META Phase 1 Site 3 - Ferryside is unlikely to be used for spawning or nursery. Any spawning sites close to the location of the pontoon installation are unlikely to be impacted by disturbance above the daily background levels from vessel traffic to the dock.

The META Phase 1 Site 3 - Ferryside is not known to contain large populations of fish or shellfish and this site is regularly disturbed by port activities creating a resilient local community. Therefore, the effect of licensable activities on the temporary disturbance of fish and shellfish habitat is considered to be **minor**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

## 5.5 Marine Mammals

### 5.5.1 Underwater noise effects from monopile installation

Underwater noise has the potential to affect marine mammals in different ways depending on the noise level and characteristics. If the frequency of impulsive and/ or non-impulsive noise emissions overlaps with the frequencies audible by marine mammals, this may influence the animal (Weilgart, 2007). The level of influence varies with distance from the source and level.

Southall *et al.* (2007) classified cetacean and seal species into functional hearing groups based on similarities in known or expected hearing capabilities. The hearing weighting function is designed to represent the bandwidth for groups of marine mammals within which acoustic exposures can have auditory effects. The categories include:

- **low-frequency (LF) cetaceans** (i.e., marine mammal species such as baleen whales);
- **high-frequency (HF) cetaceans** (i.e., marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales);
- **very high-frequency (VHF) cetaceans** (i.e., marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz);
- **phocid pinnipeds (PCW)** (i.e., true seals); and
- **other marine carnivores (OCW)** (including otariid pinnipeds (e.g., sea lions and fur seals), sea otters and polar bears).

Impulsive and non-impulsive noise can have different implications for marine mammals potentially resulting in temporary threshold shift (TTS) or permanent threshold shift (PTS). The zone of auditory injury in this study is classified as the distance over which a marine mammal may suffer a PTS leading to non-reversible auditory injury. UK Industry guidelines on the prevention of injury to marine mammals recommend that PTS is the relevant threshold considered likely to result in injury and for which appropriate mitigation should be followed (JNCC, 2010).

At lower hearing thresholds than those that can cause an instantaneous injury resulting in PTS a marine mammal may experience a TTS. The NMFS (2018) and Southall *et al.* (2007) define TTS as a 6 dB shift in the hearing threshold which is the minimum shift distinguishable from any day-to-day variation in a subject's normal hearing. The distinction between TTS and PTS depends on whether there is complete recovery of the individual's hearing. The most likely response of a marine mammal to noise levels that could induce TTS is to flee from the ensonified area (Southall *et al.*, 2007) and subsequently the onset of TTS is referred to as the fleeing response. The duration of effect can vary widely from 1 hour up to several days and, as described above, indicates the level of noise exposure which could induce any measurable shift.

This range in response makes it difficult to interpret the biological consequences of TTS, and as described for PTS, the noise modelling makes a number of precautionary assumptions that lead to the prediction of very conservative ranges. For these reasons, the TTS ranges should be interpreted with caution since in reality the injury ranges are likely to be smaller than those predicted by the modelling.

The potential ranges presented for injury and disturbance are not a hard and fast 'line' where an impact will occur on one side and not on the other. Potential impact is more probabilistic than that; dose dependency in PTS onset, individual variations and uncertainties regarding behavioural response and swim speed/direction all mean that it is much more complex than drawing a contour around a location. Therefore, it is also necessary to calculate the SEL for a mammal using the relevant weightings described previously considering the amount of sound energy to which it is exposed over the course of a 24-hour period. In order to carry out this calculation, it has been assumed that a mammal will swim away from the noise source at an average

speed of 1.5 ms<sup>-1</sup>. As the mammal swims away, the noise will become progressively quieter. The real-world situation is more complex, and the noise source will vary in space and time and the animal is likely to move in a more complex manner.

The relevant criteria for PTS and TTS are proposed by Southall *et al.* (2019) are as summarised in Table 5.5.

For this Marine Licence variation, the marine mammals of interest include harbour porpoise (VHF), bottlenose dolphin (HF), grey seal (PCW) and otter (OCW) as specified in Section 3.5.

**Table 5.5: Summary of injury (PTS and TTS) onset acoustic thresholds in marine mammals (Southall *et al.* 2019)**

Hearing Group	Parameter	Impulsive		Non-impulsive	
		PTS	TTS	PTS	TTS
High-frequency (HF) cetaceans	Peak, unweighted	230	224	-	
	SEL, MF weighted	185	170	198	178
Very High-frequency (VHF) cetaceans	Peak, unweighted	202	196	-	
	SEL, HF weighted	155	140	173	153
Phocid Carnivores in Water (PCW)	Peak, unweighted	218	212	-	
	SEL, PW weighted	185	170	201	181
Other Marine Carnivores in Water (OCW)	Peak, unweighted	232	226	-	
	SEL, OW weighted	203	188	219	199

In order to assess potential disturbance to marine mammals, criteria for non-impulsive sounds are based on NMFS (2005) and HESS (1997). The criteria are as follows:

- Potential disturbance due to non-impulsive sound: 120 dB re 1 µPa (rms).

Injury and disturbance impact ranges for the sources associated with the proposed pile installation works are summarised in Table 5.6 and Table 5.7. The distances presented in the table reflect the start point of the marine mammal relative to the source when the source first starts up. All ranges are rounded to the nearest 5 m.

**Table 5.6: Summary of potential injury and disturbance zones for rotary drilling (N/E – not exceeded)**

Species	Range of effect		
	PTS	TTS	Disturbance
Bottlenose dolphin (HF)	N/E	N/E	275 m
Harbour porpoise (VHF)	N/E	N/E	275 m
Grey seal (PCW)	N/E	N/E	275 m
Otter (OCW)	N/E	N/E	275 m

**Table 5.7: Summary of potential injury and disturbance zones for top drive drilling (N/E – not exceeded)**

Species	Range of effect		
	PTS	TTS	Disturbance
Bottlenose dolphin (HF)	N/E	N/E	240 m
Harbour porpoise (VHF)	N/E	N/E	240 m
Grey seal (PCW)	N/E	N/E	240 m
Otter (OCW)	N/E	N/E	240 m

## Harbour Porpoise

These noise modelling results indicate that the thresholds for PTS and TTS are unlikely to be exceeded for harbour porpoise during rotary drilling or top drive drilling. Disturbance may occur out to a distance of 275 m during rotary drilling and 240 m during the top drive drilling. Pile installation is expected to occur intermittently over a period of up to 60 days. Each pile is expected to take up to 1 hours to install, resulting in 10 hours of installation in total.

Harbour porpoise are regularly sighted around the south west Wales coastline and are particularly abundant around the Pembrokeshire Islands (De Boer and Simmonds, 2003). They are a qualifying feature of the West Wales Marine/Gorllewin Cymru Forol SAC; however, this SAC is 11 km from the META Phase 1 Site 3 - Ferryside. This suggests this is not ideal habitat for harbour porpoises and they are very unlikely to occur in the vicinity of the works.

## Bottlenose Dolphin

The noise modelling results indicate that the thresholds for PTS and TTS are unlikely to be exceeded for bottlenose dolphin during rotary drilling or top drive drilling. Disturbance may occur out to a distance of 275 m for rotary drilling and to a distance of 240 m for top drive drilling.

Bottlenose dolphin occurs regularly within Welsh waters with most sightings around Cardigan Bay, where there is a resident population (Baines and Evans, 2012). The latest SCANS III survey estimated density of 0.06 animals per km<sup>2</sup> across a large area of welsh coast as well as extending into the Celtic sea (Hammond *et al.*, 2017). Additionally, they have not been recognised as a qualifying feature of any designated sites in this area suggesting they are unlikely to occur in the vicinity of the works.

## Grey Seal

These noise modelling results indicate that the thresholds for PTS and TTS are unlikely to be exceeded for grey seal during rotary drilling or top drive drilling. Disturbance may occur out to a distance of 275 m for rotary drilling and to a distance of 240 m for top drive drilling.

Grey seal are a common feature along the Pembrokeshire coast especially on islands such as Skomer. They are however not commonly seen in the Waterway, with no regular haul out sites.

## Otter

These noise modelling results indicate that the thresholds for PTS and TTS are unlikely to be exceeded for otter during rotary drilling or top drive drilling. Disturbance may occur out to a distance of 275 m for rotary drilling and to a distance of 240 m for top drive drilling.

Otters have the potential to occur in the vicinity of the proposed works (see Section 3.5.3). They are a qualifying feature of the Cleddau Rivers/Afonydd Cleddau SAC and the Pembrokeshire Marine/Sir Benfro Forol SAC. Neither of these sites overlaps with the Pembroke Dock area or the proposed licensable activities and the lack of viable habitat makes them unlikely to enter the site. The META Phase 1 Site 3 - Ferryside is approximately 150 m from the border of Pembrokeshire Marine/Sir Benfro Forol SAC which leaves only a small area in which otters would experience a mild disturbance.

## Conclusion

The noise assessment has demonstrated that there is no risk of injury to any marine mammal as a result of the pile installation works and any behavioural disturbance will be limited to within 275 m of the pontoon. The noise from the port makes it unlikely that marine mammals will venture close to the works and other activities are unlikely to exceed the background noise made by the port. Therefore, the effect of underwater noise from licensable activities on marine mammals is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 ML assessment. No mitigation is required to reduce the risk of injury to marine mammals from subsea noise during pile installation.

## 5.5.2 Collision risk from vessel movements

The pontoon installation work at the META Phase 1 Site 3 - Ferryside may involve up to ten vessels on site at any one time to both install and support the installation of the monopiles. This has the potential to increase the risk of vessel collision for any marine mammals which might inhabit or visit the Waterway.

The risk of collision is higher when vessels are moving at high speeds and collisions can be fatal if the vessel is moving 13-15 knots or more (Laist *et al.*, 2001). Vessels moving in the Waterway however are limited to 5 knots, and even less than this in the docks where they will be heavily restrained in terms of movement, which greatly reduces the potential for collisions and fatalities. Furthermore, the licensable activities will only require the repositioning of vessels rather than a requirement for additional vessel trips.

Certain species are more at risk than others from collision with vessels, in the Waterway bottlenose dolphin and harbour porpoise are the most likely visitors with frequent sighting on the Welsh coast, however their low density makes their presence unlikely. Similarly, there are no known haul out sites for grey seals in the Waterway so the risk of collision with them is very low. The baseline noise and operations at the docks is likely to deter marine mammals from entering the META Phase 1 Site 3 - Ferryside, especially harbour porpoise which are highly hearing sensitive and generally avoid vessels (Miller *et al.*, 2008). Otters are the species found most commonly near the META Phase 1 Site 3 - Ferryside. Although the baseline noise and operations, as well as lack of viable habitat at the docks is highly likely to deter otters and therefore also presenting a highly reduced collision risk.

Therefore, the effect of collision risk from licensable activities on marine mammals is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

## 5.6 Shipping and Navigation

### 5.6.1 Restrictions to shipping and navigation from vessel activity

The META Phase 1 Site 3 - Ferryside is located within Pembroke Dock, an operating port area where 3rd party vessel movements occur daily. Vessel movements associated with the META Phase 1 Site 3 - Ferryside pontoon installation have the potential to restrict 3rd party vessel movements, however the META Phase 1 Site 3 - Ferryside has been selected through engagement with MHPA in order to ensure that proposed installation activities at the META Phase 1 Site 3 - Ferryside have minimal impact on ongoing port operations and recreational vessel activity. During pontoon installation, all vessel movements will be controlled by MHPA in accordance with existing navigation and safety protocols in place for Pembroke Dock. The additional ten vessels will be an increase from the number of licenced vessels however it represents a very small increase from the number of vessels that use Pembroke Dock every day. Therefore, the effect of licensable activities on shipping and navigation is considered to be **negligible**, and therefore no greater than that concluded for the original META Phase 1 Marine Licence assessment.

## 6 CUMULATIVE EFFECTS

### 6.1 Approach

The cumulative effects of activities associated with the pontoon installation activities at the META Phase 1 Site 3 - Ferryside, in conjunction with other proposed schemes will be considered within the Cumulative Effects Assessment (CEA). The META Phase 1 Site 3 - Ferryside will be assessed for impacts with other plans or projects within a pre-defined geographical area (Study Area). The geographical area may be different for different receptors. The CEA will consider any developments that are at the Scoping stage or later in the consenting process. Developments that are built and operational at the time of assessment will be considered as part of the baseline. These other activities are described in Table 6.1 and are presented in Figure 6.1.

# META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

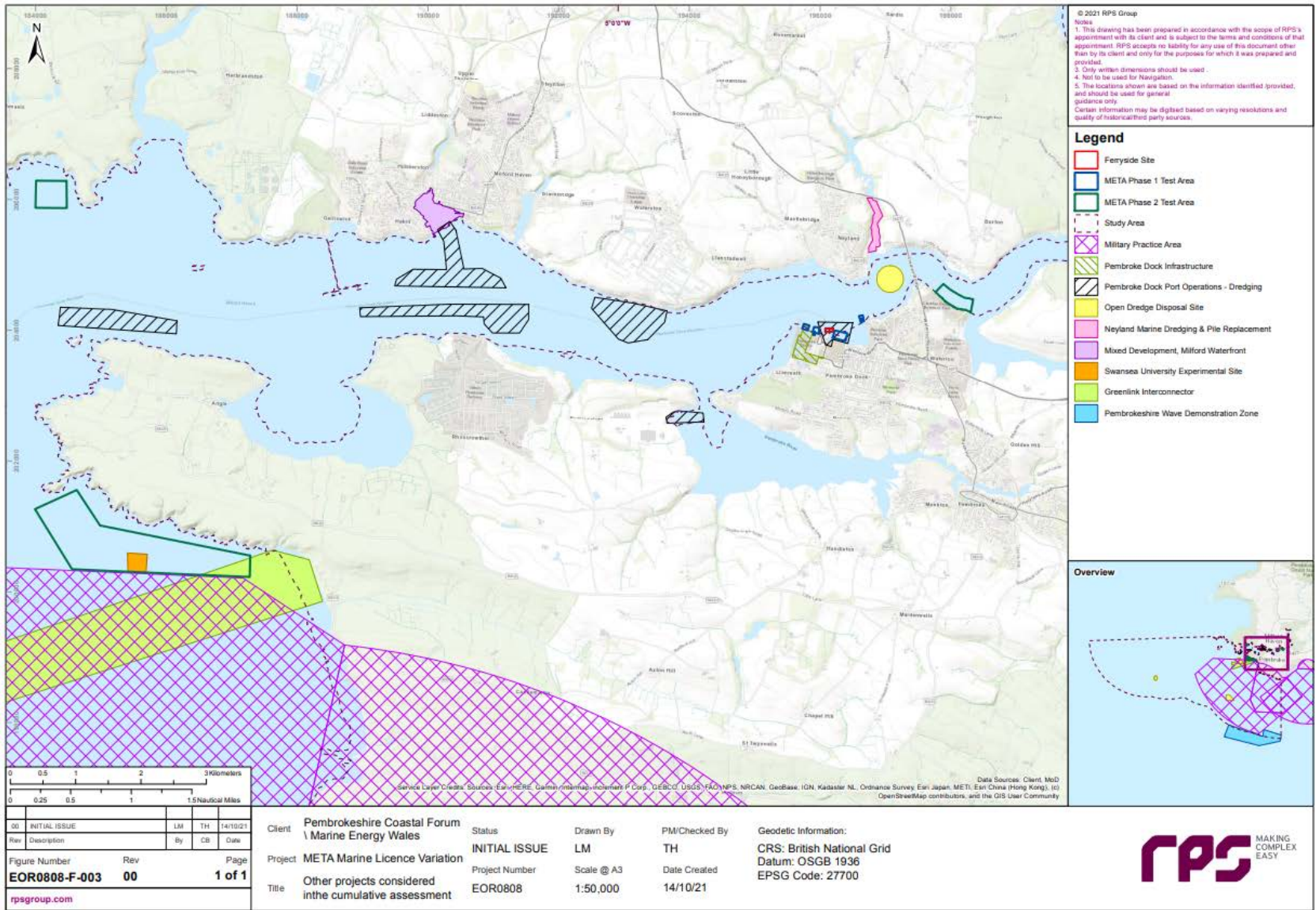


Figure 6.1: Location of projects and activities that have been considered for cumulative impact assessment

## META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

**Table 6.1: Projects and activities considered for cumulative effects assessment (CEA)**

Project (Developer)	Spatial Overlap	Temporal Overlap	Description and proposed development activities	Further Assessment Required	Justification
Pembroke Dock Port operations (MHPA)	Yes	Yes	Pembroke Dock port operations handles up to 62,000 Ro-Ro units per year. There is a requirement for ongoing Port activities such as maintenance dredging and repair work.	Yes	Port activity as a result of Pembroke Dock Port operations could cause an increase in underwater noise emissions, increased potential for suspended sediments, and impacts on shipping and navigation. There is therefore the potential for cumulative impacts with pontoon installation associated META Phase 1 Site 3 - Ferryside.
Cables/pipelines	Yes	Yes	There are a number of cables and pipelines in the vicinity of the META Phase 1 Site 3 - Ferryside.	No	Existing cables/pipelines are not expected to interact with proposed project as there are no ongoing impacts from this infrastructure on receptors and impact pathways identified for this project, and any potential impacts from existing cables/pipelines are considered to form part of the existing baseline. No new/proposed cables/pipelines are planned.
Dredging and disposal sites	In Bold	Yes	<p>DML1646 – Milford Haven maintenance dredging, 2017-2022 (MHPA). Annual volume 5,500 m<sup>3</sup>, <b>spatial overlap only with META Phase 1 Site 3 - Ferryside</b>, see Figure 6.1.</p> <p>DML1950 - Newport maintenance dredge 2020-2030. 499,999 tonnes per year. <b>No spatial overlap.</b></p> <p>DML1955- Barry maintenance dredge disposal 2019-2029. 99,999 tonnes per year. <b>No spatial overlap</b></p> <p>MMML15480 Nobel Bank marine mineral dredging 2016-2023. <b>No spatial overlap</b></p>	Yes	Sediment plumes generated from placement of material in identified disposal ground and dredging activities may present potential cumulative effects with META Phase 1 Site 3 - Ferryside licensable activities. There may also be a potential for cumulative impact from increased underwater noise from dredging and disposal activities.
Deployment of scientific equipment and marker buoys (University College of Swansea) - DEML1845	No	No	Deposition and subsequent removal of marker buoys with environmental monitoring and mid-water settlement plates, 2018-2019	No	No spatial or temporal overlap and impact pathway identified.

## META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

Project (Developer)	Spatial Overlap	Temporal Overlap	Description and proposed development activities	Further Assessment Required	Justification
Neyland Marina pile replacement - CML1658	Yes	No	Pile replacement in Neyland Marine, 2016-2019.	No	Pile replacement was completed in 2019. There is therefore no potential for cumulative underwater noise effects on identified receptors
Pembroke Dock Infrastructure (MHPA) (a Pembroke Dock Marine project)	No	Yes	The intention of the Project is to create a flexible and efficient port-related office, industrial, warehousing and distribution, and ancillary operations infrastructure. This will involve the redevelopment of its existing space to incorporate increased deep-water access, internal and external heavy fabrication areas, construction of MEECE and Education/Skills Facility and the construction of a heavy lift facility.	Yes	Despite no spatial overlap sediment plumes may travel from the META Phase 1 Site 3 - Ferryside and combine with those produced during the infrastructure development.
Pembrokeshire Wave Energy Demonstration Zone (Wave Hub Ltd.) (a Pembroke Dock Marine project)	No	Yes	The Project entails the development of 90 km <sup>2</sup> of seabed with water depths of approximately 50 metres and a wave resource of approximately 19 kW/m; to support the demonstration of wave arrays with a generating capacity of up to 30MW for each project. Consent for this Project could be achieved in 2022, infrastructure could be built by 2024 and the first technology could be installed in 2025.	No	This project will not be taken forward in the CEA as no spatial overlap with the META Phase 1 Site 3 - Ferryside has been identified (Figure 6.1).
Marine Energy Test Areas (META) Phase 2 project (a Pembroke Dock Marine project)	No	Yes	The Project aims to create pre-consented marine energy test areas within the Waterway and adjacent waters. Three test areas are proposed – Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8). The test areas will have licensable activities to suit testing of wave or tidal devices or subassemblies, and floating offshore wind components.	No	This project is to be excluded from the CEA on the grounds that there is no spatial overlap with the META Phase 1 Site 3 - Ferryside.
Mixed use development (MHPA) - LPA reference: 14/0158/PA	No	Yes	Demolition of several existing buildings and the mixed-use redevelopment of Milford Waterfront comprising up to 26,266 m <sup>2</sup> of commercial, hotel, leisure, retail and fishery related floorspace. Up to 190 residential properties, up to 70	No	Given the distance from the project and likely impact pathways. There is no potential for cumulative impacts to affect the marine environment.

## META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

Project (Developer)	Spatial Overlap	Temporal Overlap	Description and proposed development activities	Further Assessment Required	Justification
			additional marina berths, replacement boat yards, landscaping, public realm enhancements, access and ancillary works. The development was conditionally approved in November 2019.		
Cable Interconnector (Greenlink) - Welsh Government reference: qA1296053 Ground investigations - RML1827	No	Yes	The Project is a 500MW subsea electricity interconnector linking the power markets in Ireland and Great Britain and is planned for commissioning in 2023. As an EU Project of Common Interest, it is one of Europe's most important energy infrastructure projects. The interconnector is planned to make Landfall at Fresh Water West beach to the south of the mouth of the Waterway. A marine licence application was approved in March 2021.	No	This project is to be excluded from the CEA on the grounds that there is no spatial overlap with the META Phase 1 Site 3 - Ferryside.
Military practice (Ministry of Defence)	No	Yes	The Castlemartin Range is located immediately south of the entrance to the Waterway and extends for up to 12 NM from the coast between Little Furznip (at the southern extent of Freshwater West) and St Govan's Head (Milford Haven Port Authority 2019). The range at Castlemartin supports the training of military personnel (Army) in the firing of a range of munitions at land-based targets. The seaward danger area provides a safety zone for overfire and shrapnel which may result from the striking of targets (RPS, 2010). The Castlemartin Range is used every day of the week and on some weekends (RPS, 2010).	No	This project is to be excluded from the CEA on the grounds that there is no spatial overlap with the META Phase 1 Site 3 - Ferryside.
Project Erebus floating offshore wind farm (SC1905)	No	Yes	Floating offshore wind farm in the outer Severn Estuary. Project will have up to 10 wind turbine generators. Construction is expected to commence in 2026.	No	This project is to be excluded from the CEA on the grounds that there is no spatial overlap with the META Phase 1 Site 3 - Ferryside.

**META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL**

<b>Project (Developer)</b>	<b>Spatial Overlap</b>	<b>Temporal Overlap</b>	<b>Description and proposed development activities</b>	<b>Further Assessment Required</b>	<b>Justification</b>
Milford Haven Port Authority Ground Investigation Works	No	No	The project aims to replace slipways with new wider and longer structures, as well as building a new quay and new winch house. Ground investigation works are thought to take 3 months. The full project is scheduled to last from 06/05/2020 to 05/05/2021.	No	The project was expected to be completed in May 2021 and largely takes place on land with only minor works occurring in the subtidal area.
Marine Energy Test Areas (META) Phase 1 project, deposit and removal	Yes	No	Within the licenced period (10/06/2019 to 09/06/2029) the sites will be used to test marine energy devices, specifically at the META Phase 1 Site 3 - Ferryside there will be a maximum of two testing activities at once, deployed from a pontoon.	Yes	There will be spatial overlap however there will only be temporal overlap with the operational phase of the pontoon as Marine Energy Wales will not be able to install marine energy devices until the pontoon is in place.

## 6.2 Physical Processes

### 6.2.1 Increases in suspended sediment concentrations from vessel movement

The META Phase 1 project, Pembroke Dock Infrastructure project and Milford Haven maintenance dredging scoped into the cumulative assessment in Table 6.1 may also cause increased suspended sediment concentrations. The META Phase 1 project will only overlap with the operational phase of the pontoon installation and maintenance, no suspended sediments are expected as a result of the operational phase of the pontoon therefore there is no impact pathway for a cumulative impact. The Pembroke Dock Infrastructure project involves the construction of new berths and larger slipway which could contribute to greater levels of suspended sediments. The works will occur at the other end of the docks to the META Phase 1 Site 3 - Ferryside and have the potential to overlap temporally, although the effect on suspended sediment concentration from both projects are temporary. In the case of the META Phase 1 Site 3 – Ferryside, pontoon and pile installation will occur over a very short duration (i.e. hours), and for this project alone the effect has been considered to be negligible. Therefore the cumulative impact of these projects is unlikely to represent a significant change in the baseline suspended sediment concentrations which is influenced by the continuous daily impact of the traffic from Pembroke Port. The Milford Haven maintenance dredging may extract up to 5,500 m<sup>3</sup> per year overlapping with the META Phase 1 Site 3 - Ferryside. It is unlikely that maintenance dredging will occur at the same time as installation of the pontoon and the suspended sediments created as a result of the pontoon installation are not expected to be greater than baseline levels. Therefore, the cumulative impact is expected to be **negligible**.

### 6.2.2 Changes to wave conditions from pontoon installation

The META Phase 1 project scoped into the cumulative assessment in Table 6.1 may also cause a change to wave conditions as a result of the installation of marine energy devices and placement of the pontoon. Deployment of marine energy devices will be temporary whilst (maximum 3-6 months, most likely 1-3 months) potential impacts would be temporary in nature. This impact was considered to be negligible (RPS Energy, 2019). Placement of the pontoon will be the same as per the original consent and is considered to have a negligible effect on wave conditions. The cumulatively of this project with the additional installation pontoon piles is considered to be **negligible**.

## 6.3 Benthic Ecology

### 6.3.1 Habitat disturbance/loss associated with monopile and pontoon installation

The Milford Haven maintenance dredging, as well as the META Phase 1 project, scoped into the cumulative assessment in Table 6.1 may also cause disturbance to benthic habitats. The META Phase 1 project will not overlap temporally with the monopile installation as the pontoons require the monopile for mooring. As a result, there is no impact pathway for a cumulative impact. The maintenance dredging undertaken by Milford Haven port authority may have a cumulative impact alongside the installation of the pontoon. The dredging is undertaken yearly to remove sediments which have accumulated since the last dredge to maintain the ports depth. The maintenance dredging overlaps with the META Phase 1 Site 3 - Ferryside therefore this project will result in repeat disturbance of the same habitat and will not result in a greater area of habitat disturbance than the maintenance dredging alone. The META Phase 1 Site 3 - Ferryside experiences high levels suspended sediment concentrations regularly due to the port operations and the increase from the dredging and pontoon installation is unlikely to exceed this background level. Given this level of regular disturbance the cumulative impact of these activities on benthic habitats is considered to be **negligible**.

### 6.3.2 Increases in suspended sediment concentrations

The META Phase 1 project, Pembroke Dock Infrastructure project and Milford Haven maintenance dredging scoped into the cumulative assessment in Table 6.1 may also cause increased suspended sediment concentrations. As described under section 6.2.1, the cumulative impact of an increase in SSC is expected

to be negligible therefore the impact on benthic receptor as a result in an increase in SSC is also predicted to be **negligible**.

## 6.4 Fish and Shellfish Ecology

### 6.4.1 Underwater noise effects from monopile installation

The Milford Haven maintenance dredging, as well as the META Phase 1 project, scoped into the cumulative assessment in Table 6.1 may also cause underwater noise. All of these projects are involved in increasing the number of vessels active in the area. The vessels necessary for the META Phase 1 project will not be active until after the installation of the monopiles therefore there is not impact pathway for cumulative impacts due to a lack of temporal overlap. Should the vessels necessary for the Milford Haven maintenance dredging overlap temporally or spatially with the monopile installation it is unlikely the cumulative effect would exceed the background noise generated by neighbouring Pembroke Docks which large vessels operate out of on a daily basis as stated in Section 5.4.1. Additionally, the effect of these vessels is likely to further deter fish from entering the site. Therefore, any cumulative impact from underwater noise on fish and shellfish **negligible**.

### 6.4.2 Temporary habitat disturbance associated with pontoon installation

The Milford Haven maintenance dredging, as well as the META Phase 1 project, scoped into the cumulative assessment in Table 6.1 may also cause disturbance to fish and shellfish. Due to the mobile nature of fish the temporal overlap of these projects could result in a cumulative reduction in available habitat. The META Phase 1 project does not temporally overlap with the monopile installation and is unlikely to overlap with the pontoon installation therefore a cumulative impact between these projects is unlikely. As noted in Table 6.1, the Milford Haven maintenance dredging site overlaps spatially with the META Phase 1 Site 3 - Ferryside therefore this projects will result in repeat disturbance of the same habitat and will not result in a greater area of habitat disturbance than the maintenance dredging alone. It is unlikely that dredging will occur at the same time as the installation of the pontoon. Furthermore the seabed footprint of the pontoon installation will be very small (137.64 m<sup>2</sup>) and therefore will not add greatly to total seabed disturbance. Additionally, the mobile nature of fish and the availability of wider suitable habitat means that the effect would be minimal as they are likely to vacate the area temporarily due to noise from dredging and pontoon installation. Shellfish are sessile and therefore may be more affected by temporary habitat disturbance however, as stated in Section 6.3.1, the effect on fish and shellfish are likely to be negligible. Given the scale of the impacts and the mobile nature of fish the cumulative effects of these activities on fish and shellfish habitats are considered to be **negligible**.

## 6.5 Marine Mammals

### 6.5.1 Underwater noise effects from monopile installation

The Milford Haven maintenance dredging, as well as the META Phase 1 project, scoped into the cumulative assessment in Table 6.1 may also cause underwater noise which could affect marine mammals. All of these projects could increase the number of vessels active in the area. The vessels necessary for the META Phase 1 project will not be active until after the installation of the monopiles therefore there is no impact pathway for cumulative impacts due to a lack of temporal overlap. Should the vessels necessary for the Milford Haven maintenance dredging overlap temporally or spatially with the pontoon installation it is unlikely the cumulative effect would exceed the background noise generated by neighbouring Pembroke Docks which large vessels operate out of on a daily basis as stated in Section 5.4.1. Additionally, the effect of these vessels is likely to further deter marine mammals from entering the site. Therefore, any cumulative impact from underwater noise on marine mammals is **negligible**.

### 6.5.2 Collision risk from vessel movements

The Milford Haven maintenance dredging, and the META Phase 1 projects scoped into the cumulative assessment in Table 6.1 may also cause an increase in the collision risk from vessel movements to marine mammals. These projects may increase the number of vessels in the waterway. The META Phase 1 project at the META Phase 1 Site 3 - Ferryside cannot commence until the pontoon is installed therefore there is no

temporal overlap and no impact pathway for a cumulative increased vessel collision risk. The vessels used for the Milford Haven maintenance dredging vessel have the potential overlap spatially and temporally with the pontoon installation depending on their port or origin. As discussed in Section 3.5 marine mammals have not generally been identified this far into the estuary and those that have will likely avoid the area due to the noise and operations of the Pembroke Docks. Furthermore, all the vessels will be restricted to 5 Knots within the Waterway making the risk of a collision negligible. Overall, the potential for cumulative impact of marine mammal collision risk from vessel movement is considered to be **negligible**.

## 6.6 Shipping and Navigation

### 6.6.1 Restrictions to shipping and navigation from vessel activity

All of the projects scoped in Table 6.1 will increase vessel activity in and around the port potentially restricting shipping and increasing the vigilance necessary for navigation. The potential total number of vessels which could be active over the period of the monopile installation is unknown. Vessel activity associated with each project including proposed construction works, will be managed, and approved by MHPA and via a vessel management plan. Cumulative restrictions to shipping and navigation from identified projects are therefore considered to be negligible.

## 7 HRA SCREENING: CONSIDERATION OF LIKELY SIGNIFICANT EFFECTS

The locations of the META Phase 1 Site 3 - Ferryside in relation to the National Sites Network identified in Section 3.7 are shown in Figure 3.1. The need to consider the potential for Likely Significant Effect (LSE) on these sites is discussed below. It should be noted that “Likely Significant Effect” is terminology used by both EIA Regulations and The Conservation of Habitats and Species Regulations 2017 (Habitats Regulations). As such, in the context of this Environmental Appraisal, the use of “Likely Significant Effect” is as defined by the Habitat Regulations 2017.

The HRA screening step (LSE) is the process by which the likely effects of a project upon a European site, either alone or in combination with other projects and plans, consider whether these effects may be significant. The assessment must show that there will be no significant effect, and if there is any uncertainty or where it cannot be determined that there is no LSE, an Appropriate Assessment is required.

### 7.1 Pembrokeshire Marine/ Sir Benfro Forol SAC

The Pembrokeshire Marine/ Sir Benfro Forol SAC lies immediately to the north of the META Phase 1 Site 3 - Ferryside and covers an area of 1380.38 km<sup>2</sup> extending from just north of Abereddy on the north Pembrokeshire coast, to just east of Manorbier in the south, and includes the coast of the islands of Ramsey, Skomer, Grassholm, Skokholm, the Bishops and Clerks and The Smalls.

#### 7.1.1 Estuaries, Reefs, Large Shallow Inlets and Bays (Primary habitat feature), and Mudflats and Sandflats not covered by seawater at low tide (Secondary habitat feature)

Pembrokeshire Marine /Sir Benfro Forol SAC comprises a wide range of environmental conditions, particularly seabed substrates, tidal streams, and salinity gradients, which in turn supports a wide diversity of marine communities and species. The species-richness of sediment communities throughout Milford Haven is high. The site includes smaller estuaries entering the Waterway, and wide intertidal mudflats with rich and productive invertebrate annelid and mollusc communities, occurring in ‘pills’ (creeks).

All works will occur outside of the SAC site boundary (all META Phase 1 sites are out with the SAC), therefore there will be no direct impact on the ‘Estuaries’, ‘Reefs’, ‘Large Shallow Inlets and Bays’ or ‘Mudflats and Sandflats not covered by seawater at low tide’ qualifying interest features of the SAC. Given that there is no spatial overlap with the SAC site boundary, no LSE is predicted.

#### 7.1.2 Grey Seal

The grey seal population in Pembrokeshire Marine/Sir Benfro Forol SAC represents the largest breeding colony on the west coast south of the Solway Firth, representing over 2% of annual UK pup production (JNCC, 2021). The Pembrokeshire coast contains the main colony in Wales and is the most southerly in Europe of any significant size (NRW, 2017a). Grey seals present within the SAC at any one time do not form a discrete population but are centred (in terms of abundance) on the Pembrokeshire coast and are considered part of the SW England and Wales management unit (IAMMWG, 2013). Adults and weaned pups are assumed to feed throughout the site, and some are known to make long foraging trips offshore to deeper waters from south through south-west to north-west off the Pembrokeshire coast. Popping tends to occur at a limited number of favourable sites (towards the south-western end of the SAC). The most recent estimates for pup production at the major haul-outs in Wales are 465 pups in North Pembrokeshire in 2005 (Strong *et al.*, 2006) and 243 pups born on Skomer island in 2020 (NRW, 2020). They are generalist predators (Section 3.5.2).

No reduction to the population, range or structure of the grey seal population as a result of the proposed META Phase 1 Site 3 - Ferryside pontoon installation is predicted due to the restricted nature of licensable activities proposed, and the very low numbers of animals predicted at the META Phase 1 Site 3 - Ferryside. Pile installation is not expected to cause injury (PTS or TTS) in grey seals and behavioural effects are likely to occur over small ranges (up to 275 m) only.

On this basis, no significant disturbance of the species is predicted, and grey seal will remain a viable component of the site. It can, therefore, be concluded that there is no potential for LSE as a result of the proposed pontoon installation works.

### 7.1.3 Migratory fish species

Twaite shad and Allis shad are Annex II species present as qualifying interest features, but not primary reasons for the selection of the Pembrokeshire Marine/Sir Benfro Forol SAC. Shad migrate through estuaries in March-May on their way to spawning grounds and most adults die after spawning, but a proportion of UK fish are known to repeat spawn: these presumably migrate back to sea immediately after spawning in June-July. Juveniles generally migrate from estuaries between August and October, where they spend some time feeding. Further seaward migration is triggered by falling temperatures in winter, but it is possible that at least a proportion of the juvenile fish overwinter in the estuary. At all stages of their life cycle, shad are pelagic fish, and in estuaries the juveniles predominantly occur in the surface layers of the water column.

Adult river lampreys migrate through the Pembrokeshire Marine/Sir Benfro Forol SAC to reach the Afonydd Cleddau river on their spawning migration, entering freshwater between October and December. Juvenile river lampreys generally migrate downstream into estuaries and inshore waters in spring, though autumn migrations have also been recorded. Since river lampreys feed and grow in estuaries and inshore waters, it should be assumed that juveniles are present in the Pembrokeshire Marine SAC throughout the year.

Adult sea lampreys migrate through the site between March and June to reach the Afonydd Cleddau. Mature adults enter the estuaries from April onwards and migrate some distance upstream. Juvenile sea lampreys migrate downstream between December and June and spend some time feeding in the estuary and inshore waters before moving offshore in search of larger prey. However, no sea lamprey has been recorded in the monitoring of the SAC since 2004 so there is no evidence that the site currently supports sea lamprey.

Whilst there is potential for fish to enter/pass through META Phase 1 Site 3 - Ferryside, no barriers to migration or potential impact have been identified and the META Phase 1 Site 3 - Ferryside is unlikely to be used for spawning (given the high levels of disturbance of the Pembroke Dock area). As detailed in Section 5.4.1, there is little potential for TTS/PTS to be experienced by fish due to the rotary drilling or top drive drilling. There is a moderate to high risk of behavioural effects in the near field (i.e., within tens of metres) and moderate risk in the intermediate field (i.e. within hundreds of metres) for shad and lamprey. It is considered highly unlikely that shad and lamprey will be within the docks and given that the majority of behavioural effects will be limited to within the Pembroke Dock area, underwater noise associated with the monopile installation is unlikely to present a barrier to migration. Pontoon installation either alone or in combination with other plans or projects (Section 6) are therefore not expected to have a significant impact on these qualifying interest features of the Pembrokeshire Marine /Sir Benfro Forol SAC. It can, therefore, be concluded that there is no potential for LSE as a result of the proposed pontoon installation works.

### 7.1.4 Otter

The otter population in Wales is increasing and there has been an increase in areas used by otters. Any otters present within the SAC are part of a wider population living around freshwater habitats in Pembrokeshire. It is likely that there are movements and exchanges between areas supporting otters. The proportion of the otter population within the SAC at any time, and its distribution, is likely to be dynamic and it is not known whether the numbers of animals that use the site are a fixed or variable proportion of the wider population with a preference for using marine habitat.

As discussed in Section 5.5.1, it is considered highly unlikely that PTS/TTS will be experienced by otter during the pile installation activities and behavioural disturbance would be limited to within 275 m. On this basis, no significant disturbance of the species is predicted, and otter will remain a viable component of the site. It can, therefore, be concluded that there is no potential for LSE as a result of the proposed pontoon installation works.

## 7.2 Cleddau Rivers/Afonydd Cleddau SAC

The Cleddau Rivers/Afonydd Cleddau SAC lies 11 km north from the META Phase 1 Site 3 - Ferryside. The River Cleddau is one of the westernmost rivers in Britain and can be broadly divided into the eastern and western arms. The Eastern Cleddau River, starting at an altitude of 225 m and approximately 1.5 km from Mynachlog-ddu at the foot of the Preseli hills of north Pembrokeshire, flows for 26 km (74 km including

tributaries) south to its tidal limit at Blackpool Bridge, where it discharges into the Pembrokeshire Marine/ Sir Benfro Forol SAC. The main channel of the Western Cleddau River stretches for 30 km between its source at Mathry, which lies at an altitude of 112 m, to the tidal limit of the Daugleddau Estuary at Haverfordwest, flowing over sands and gravels deposited as the ice sheets from the last glaciation retreated.

### 7.2.1 Migratory fish species

For the Cleddau Rivers/Afonydd Cleddau SAC, no impact is expected for the group 1 sea and river lamprey, which are designated for this site, from pile installation, except potential behavioural changes in the near field. As detailed in Section 5.4.1, there is little potential for TTS/PTS to be experienced by fish due to the rotary drilling or top drive drilling. There is a moderate risk of behavioural effects in the near field (i.e. within tens of metres) and intermediate field (i.e. within hundreds of metres) for lamprey. It is considered highly unlikely that lamprey will be within the docks and given that the majority of behavioural effects will be limited to within the Pembroke Dock area, underwater noise associated with the monopile installation is unlikely to present a barrier to migration. Pontoon installation either alone or in-combination with other plans or projects (Section 6) are therefore not expected to have a significant impact on these qualifying interest features of Cleddau Rivers/Afonydd Cleddau SAC.

The minimal and unlikely risk of disturbance uphold the conservation objectives within the SAC by preventing any significant disturbance.

As mentioned in the Section 6.4.1, no barriers to migratory routes are predicted during the installation of the META Phase 1 Site 3 - Ferryside pontoon, and the META Phase 1 Site 3 - Ferryside is not typically used for spawning (given the high levels of disturbance of the Pembroke Dock area). It can, therefore, be concluded that there is no potential for LSE as a result of the proposed pontoon installation works.

### 7.2.2 Otter

The SAC is capable of supporting 11 breeding females on the Western Cleddau, and eight breeding females on the Eastern Cleddau. This is determined by the number of existing breeding territories as identified by Jones and Jones, (2004). Food availability is an important factor. Fish biomass should stay within expected natural fluctuations as there is no spatial overlap with the SAC and the META Phase 1 Site 3 - Ferryside. As discussed in Section 6.5.1, it is considered highly unlikely that PTS/TTS will be experienced by otter during the pile installation activities and behavioural disturbance would be limited to within 275 m. On this basis, no significant disturbance of the species is predicted, and otter will remain a viable component of the site. Due to the considerable distance within the known territorial ranges (1 – 40 km) of otter as a qualifying interest feature of the SAC and the META Phase 1 Site 3 - Ferryside, there is no potential route to impact, therefore no LSE can be concluded.

## 7.3 West Wales Marine / Gorllewin Cymru Forol SAC

The West Wales Marine/Gorllewin Cymru Forol SAC is located off the coast of Wales, from the Llŷn peninsula in the north, to Pembrokeshire in the south-west, covering 7,376 km<sup>2</sup>. It was designated in 2019 for harbour porpoise. This SAC overlaps a number of other SACs including parts of the Pembrokeshire Marine and Pen Llŷn a'r Sarnau SACs and overlaps entirely with the Cardigan Bay SAC. Along the westward boundary, water depths of up to 100 m are reached, though much of the site is 50 m or shallower. The area included within the site covers important summer habitat for harbour porpoise, while part of the site in Cardigan Bay was also identified as important during the winter.

### 7.3.1 Harbour Porpoise

Harbour porpoise are the most abundant cetacean in UK waters, with the West Wales Marine site being identified as being within the top 10% of persistent high-density areas for harbour porpoise in UK waters during the summer season. It is estimated (based on the SCANS-II survey which took place in July 2005) that the SAC supports approximately 2,506 individuals (95% Confidence Interval: 1410 - 4455) for at least part of the year, as seasonal differences are likely to occur. This represents approximately 9% of the population within the UK part of the Celtic and Irish Sea MU (NRW and JNCC, 2015). Key prey items vary during the year but include species with pelagic and demersal habitats such as whiting, sandeels, and herring.

Although there is the potential for harbour porpoise to enter the Waterway, there are no records of this species occurring within the Waterway on the NBN gateway, and therefore the abundance within the Waterway itself is predicted to be extremely low/negligible, with any animals that do occur more likely to be present at the mouth of the Waterway. The main potential impact of the META Phase 1 Site 3 - Ferryside pontoon installation on marine mammals is disturbance due to vessel and pile installation noise and collision risk with vessels (Section 6.5.2).

In the unlikely event that a harbour porpoise is present within the META Phase 1 Site 3 - Ferryside, it can be assumed that the animal would be tolerant of existing levels of vessel noise already in the Waterway, and no disturbance of the animal would therefore be likely. As described in Section 6.5.2, due to the very slow speed of the vessels that will be used to support the META Phase 1 Site 3 - Ferryside licensable activities, and the short distance (i.e. <1 km) which they will travel within the port area, the risk of collision with marine mammals is considered to be extremely low. It is more than likely marine mammals will avoid the area due to background noise levels already occurring within the Waterway therefore avoiding direct contact with vessel movements.

As described in Section 5.5.1, there is predicted to be no risk of injury (TTS or PTS) to harbour porpoise due to the rotary drilling activities. Disturbance to harbour porpoise, could occur during pile installation, although the predicted ranges were small (up to 275 m) and so will be largely limited to within the boundaries of Pembroke Dock. It is considered highly unlikely that harbour porpoise will occur within the docks due to the operation of dock vessels and vessels associated with the pontoon installation works.

On this basis, no significant disturbance of the species is predicted, and harbour porpoise will remain a viable component of the site. The potential for a significant effect on harbour porpoise from the META Phase 1 Site 3 - Ferryside pontoon installation, either alone or in-combination with other plans or projects is negligible due to the very small area of disturbance, therefore no LSE can be concluded.

## 8 WATER FRAMEWORK DIRECTIVE ASSESSMENT

EU Directive 2000/60/EC, better known as the Water Framework Directive (WFD), established a framework for community action in the field of water policy. The WFD came into force in 2000 and requires EU Member States to ensure that all inland and coastal waters achieved 'good' water quality status by 2015 (the WFD has been retained in UK following the UK's exit from the European Union). The aims of the WFD are for the UK to:

1. Implement the necessary measures to prevent deterioration of the status of all bodies of surface water;
2. Protect, enhance and restore all bodies of surface water, subject to the application of subparagraph (iii) for artificial and heavily modified bodies of water, with the aim of achieving good surface water status by 2015;
3. Protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015; and
4. Implement the necessary measures in accordance with Article 16 (1) and (8), with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances.

Further background on the legislation and process can be found in the original marine licence application environmental appraisal.

### 8.1 WFD Waterbodies

The project has the potential to impact on two WFD water bodies either directly or indirectly: transitional water body Milford Haven Inner, and coastal waterbody Milford Haven Outer. The Milford Haven Inner waterbody overlaps with the footprint of the pontoon works at the META Phase 1 Site 3 - Ferryside. The Milford Haven Outer waterbody is located approximately 2 km to the west of the pontoon works at the META Phase 1 Site 3 - Ferryside.

A baseline description of the biological, physico-chemical and hydromorphological quality elements, as presented in the Water Framework Directive (2000/60/EC) are provided in Section 3.2 to Section 3.6 (inclusive) for Milford haven Inner and Milford Haven Outer respectively.

#### 8.1.1 Milford Haven Inner Waterbody

The Milford Haven Inner waterbody's current overall potential to meet its objectives is 'Moderate', with ecological potential as 'Moderate (very certain)' and Chemical Status as 'Fail' (WWW, 2018). Current justification for not meeting the overall status objective of 'Good' is that proposed mitigation measures are disproportionately expensive or technically not feasible (WWW, 2018).

The reason for failing to meet good ecological status is due to high levels of dissolved inorganic nitrogen and macroalgae. Justification for not achieving good status by 2015 is because mitigation measures are not in place as they are disproportionately expensive.

The reasons for the chemical status of fail are currently not specified, and mitigation measures are currently not in place.

As such the current status objective for this waterbody is to attain an overall objective of Good by 2027 (WWW, 2018).

**Table 8.1: Milford Haven Inner waterbody WFD features and objectives**

Water Body <sup>2</sup>	Description, notes or more information
WFD water body name	Milford Haven Inner
Water body ID	GB531006114100
River basin district name	Western Wales
Catchment	Cleddau and Pembrokeshire Coastal Rivers TraC
Water body type (estuarine or coastal)	Transitional
Water body total area (km2)	21.02
Overall waterbody status (2015)	Moderate
Ecological status	Moderate
Chemical status	Fail
Target water body status and deadline	Good 2027
Hydromorphology status of waterbody	Supports Good
Heavily modified waterbody and for what use	No
Phytoplankton Status	High
History of Harmful Algae	Not monitored
Angiosperm Status	High
Invertebrates' status	Good
Macroalgae status	Moderate
Fish status	Good
WFD protected areas within 2 km	Yes

### 8.1.2 Milford Haven Outer waterbody

The Milford Haven Outer waterbody’s current overall potential to meet its objectives is ‘Moderate’, with ecological potential as ‘Moderate (very certain)’ and Chemical Status as ‘fail’. Current justification for not meeting the overall status objective of ‘Good’ is that proposed mitigation measures are disproportionately expensive or technically not feasible (WWW, 2018).

The reason for failing to meet good ecological status is due to high levels of dissolved inorganic nitrogen. Justification for not achieving good status by 2015 is because mitigation measures are not in place as they are disproportionately expensive.

It is currently not specified the reasons for the chemical status of fail, and mitigation measures are currently not in place.

As such the current status objective for this waterbody is to attain an overall objective of Good by 2027.

**Table 8.2: Milford Haven Outer waterbody WFD features and objectives**

Water Body <sup>3</sup>	Description, notes or more information
WFD water body name	Milford Haven Outer

<sup>2</sup> Water body information was extracted from Water Watch Wales website. Magic maps provided additional information on habitats and protected areas.

<sup>3</sup> Water body information was extracted from Water Watch Wales website. Magic maps provided additional information on habitats and protected areas.

Water Body <sup>3</sup>	Description, notes or more information
Water body ID	GB641008220000
River basin district name	Western Wales
Catchment	Not Applicable
Water body type (estuarine or coastal)	Coastal
Water body total area (km2)	35.39
Overall water body status (2015)	Good
Ecological status	Moderate
Chemical status	Good
Target water body status and deadline	Good 2027
Hydromorphology status of water body	Supports Good
Heavily modified water body and for what use	No
Phytoplankton status	High
History of Harmful Algae	Not monitored
Angiosperm status	Good
Invertebrates' status	Not monitored
Macroalgae status	Good
Fish status	Not monitored
WFD protected areas within 2km	Yes

A WFD assessment can comprise of up to three stages. All stages may not require completion dependent on the outcomes of each stage. The stages are:

- Screening – excludes any activities that do not need to go through the scoping or impact assessment stages.
- Scoping – identifies the receptors that are potentially at risk from your activity and need impact assessment.
- Impact assessment – considers the potential impacts of your activity, identifies ways to avoid or minimise impacts, and shows if your activity may cause deterioration or jeopardise the water body achieving good status.

## 8.2 Screening

The aim of the WFD assessment screening stage is to ensure that only those activities that may cause deterioration or prevent a water body from meeting its objectives are assessed further. The screening stage excludes any low-risk activities that do not require a WFD scoping to be undertaken and therefore associated impact assessment.

According to the Table 5, Appendix 4 of the NRW OG072 guidance document (NRW, 2018), detailed assessment is required for the META Phase 1 Site 3 - Ferryside, as the installation of the pontoon does not fall into any of the listed categories of activities where assessment is not required (NRW 2018).

## 8.3 Scoping

Scoping assists with identifying elements within water bodies which may be impacted as a result of the activity, these will then progress to detailed compliance assessment. As part of scoping, the focus is on identifying components of the activity or project that have the potential to cause an impact and the quality elements potentially impacted (NRW 2018). A scoping assessment should be undertaken for each water body potentially affected by the project. Water bodies can be scoped out at this stage if it can be robustly demonstrated that there will be no impacts.

A scoping exercise was completed for project activities against the receptors and criteria provided in the NRW OGN072 guidance note (NRW 2018) for two waterbodies, Milford Haven Inner and Milford Haven Outer, that were identified as being potentially impacted by the META Phase 1 Site 3 - Ferryside pontoon installation. Results of the scoping assessment are provided in Appendix B. A summary of the scoping results is provided below in Table 8.3.

## META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

**Table 8.3: Summary of results from scoping assessment undertaken and detailed in Appendix A**

Receptor	Waterbody	Potential risk to receptor	Note the risk issue(s) for impact assessment
Hydromorphology	Milford Haven Inner	Yes	Potential for altering the process of sediment transport within the water. Deployment of monopiles has the potential to cause changes to the hydrodynamic regime within the waterbody.
	Milford Haven Outer	No	The project will not affect the physical form or cause changes to sediment transport within the waterbody, depth or intertidal zone structure
Biology	Milford Haven Inner	Yes	Biological Quality Elements benthic invertebrates have been taken forward for further assessment.
	Milford Haven Outer	No	No potential impacts are predicted to biological quality elements.
Fish	Milford Haven Inner	Yes	Underwater noise effects during pile installation, vessel movements and operation have the potential to cause disturbance effects to fish.
	Milford Haven Outer	Yes	Underwater noise effects during pile installation, vessel movements and operation have the potential to cause disturbance effects on migratory fish associated with the waterbody.
Water quality	Milford Haven Inner	No	Sediment plumes generated by pile installation and propeller wash that cause changes to water clarity will not extend for more than a few hours following operation and not continuously for a spring tidal cycle.
	Milford Haven Outer	No	As above
Protected areas	Milford Haven Inner	Yes	Within 2 km of the project footprint the following protected areas are found: <ul style="list-style-type: none"> <li>• Pembrokeshire Marine /Sir Benfro Forol SAC (~150 m from project footprint)</li> <li>• Shellfish waters (1,770 m from project footprint)</li> </ul>
	Milford Haven Outer	Yes	As above
Priority Habitats and Species	Milford Haven Inner	Yes	Several listed migratory and non-migratory fish species, harbour porpoise, and listed marine habitats exist within the waterbody.
	Milford Haven Outer	Yes	Several listed migratory and non-migratory fish species, harbour porpoise, and listed marine habitats exist within the waterbody.
Invasive non-native species	Milford Haven Inner	No	The pontoon equipment will be based onshore or on a support vessel that will be transported to site from within the Waterbodies
	Milford Haven Outer	No	As above

## 8.4 Detailed Compliance Assessment

This section considers the potential impacts of an activity, identifies ways to avoid or minimise impacts, and concludes if the activity may prevent any quality element within any waterbody achieving good status/potential or may cause deterioration.

Receptors or features identified as part of the scoping stage have been brought through for detailed assessment. Listed priority species and habitats have been included as part of Section 3.7. Section 7 addresses the impact on identified protected areas and in particular special areas of conservation within the two waterbodies, which forms part of the shadow Habitat Regulations Screening Assessment and the overall Marine Licence variation application to NRW-MLT.

### 8.4.1 Hydromorphology

Within the immediate vicinity of the META Phase 1 Site 3 - Ferryside and the Pembroke Dock area, Carrs Rock, immediately to the west of Carr Jetty, and Hobbs Point to the east of Criterion Jetty, are geological submerged bedrock features. These features deflect tidal currents flowing in a westerly direction downstream and forces the flow to the north side of the Waterway. As a result, these hydrodynamic and transport processes described above are deflected and dissipated, providing shelter in their lee (Section 5.2).

Section 5.3 discussed the impacts to hydrodynamic regime and sediment transport from the project. Deployment of the pontoon with monopiles within the water column, will likely result in highly localised effects given that the size of components/subassemblies are relatively small, and background current velocities are low. It is not expected that the proposed changes will result in significant changes to the hydrodynamic regime of the waterbody and not affect the WFD objectives of Milford Haven Inner waterbody being achieved.

### 8.4.2 Biology- Benthic Invertebrates

As discussed in Section 5.3 an area of marine habitat may be disturbed through the use of jack up vessels for the pontoon installation, the installation of the pontoon piles and occasional vessel anchoring.

A small area of temporary and permanent habitat loss in Milford Haven Inner Waterway may result in mortality of sessile benthos associated with the priority listed intertidal and subtidal sand and mud sediments within site boundaries. These are dominated by benthic fauna such as *Hediste diversicolor* and *Macoma balthica* in intertidal areas, and by annelids and bivalves in sub tidal areas. There is also the potential for mortality of some associated mobile species. This would lead to a temporary, localised loss of abundance; however, recovery is likely to occur with a similar suite of species re-colonising once the pontoon is installed. Recovery rates will depend on the reproductive strategy of the disturbed species although the species disturbed would likely be tolerant to disturbance events given, they are located within an operational port. Identified habitats within site boundaries are extensive throughout the waterway and therefore the temporary reduction of habitats will not cause the extent of the habitat to significantly change within the Waterway.

Due to the potential reduction in a very small area of habitat in the context of the large extent of similar habitat throughout the Waterway and high potential for recovery of benthic communities, the effect of habitat loss on benthic communities as a result of component/subassembly placement is predicted to not result in the deterioration of benthic communities and the WFD objectives of the waterbody restricted from being achieved by the project.

### 8.4.3 Biology- Fish

The fish assemblages of the Waterway are typical of an estuarine environment with different characterising species towards the outer reaches of the estuary compared to the inner estuary, reflecting the changes in environmental conditions present, including substrate type, water flow and salinity. Nineteen species of fish including elasmobranchs, (thornback ray *Raja clavata*, lesser spotted dogfish *Scyliorhinus caniculus*), demersal flat fish (plaice *Pleuronectes platessa*) and abundant gobies have previously been recorded within identified waterbodies.

Several migratory fish species migrate through the estuary between seawater and freshwater, all of which are of conservation importance as Annex II species protected under European legislation or as Welsh BAP

priority species. Four of the species of diadromous fish are qualifying interest features of the Pembrokeshire Marine/Sir Benfro Forol SAC: sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, allis shad *Alosa alosa* and twaite shad *Alosa fallax*. River lamprey and sea lamprey are qualifying interest features of the Cleddau Rivers/Afonydd Cleddau SAC. Atlantic salmon, sea trout and European eel are all listed as OSPAR threatened/declining species and are listed as Welsh BAP priority species.

Fish species that are mentioned above and listed as priority species under Section 7 of the Environment (Wales) Act 2016 include:

- Sand-eel (*Ammodytes marinus*);
- Tope shark (*Galeorhinus galeus*);
- Herring (*Clupea harengus*);
- Whiting (*Merlangius merlangus*);
- Thornback ray (*Raja clavate*);
- Mackerel (*Scomber scombrus*);
- Sole (*Solea solea*);
- Plaice (*Pleuronectes platessa*);
- Allis shad (*Alosa alosa*);
- Twaite shad (*Alosa fallax*);
- European eel (*Anguilla Anguilla*);
- River lamprey (*Lampetra fluviatilis*);
- Smelt (*Osmerus eperlanus*);
- Sea lamprey (*Petromyzon marinus*);
- Atlantic salmon (*Salmo salar*); and
- Brown / Sea trout (*Salmo trutta*).

As discussed in Section 5.4.1, underwater noise emissions may be produced from pile installation and vessels engines. Noise from vessels is received as a low-level exposure (as opposed to acute impulse and intense noises from e.g., pile installation) and can affect fish and shellfish by masking of important acoustic cues and behavioural disturbance (Popper and Hastings, 2009). Rotary drilling or top drive drilling will create continuous non-impulsive sound. The noise created by either drilling methods is not expected to impact on noise sensitive fish.

Behavioural effects in fish as a response to vessel noise, include a wide variety of responses including startle responses, strong or mild avoidance behaviour, changes in swimming or schooling behaviour or changes of position in the water column. For example, research looking at biases of vessel noise on the spatial distribution of fish showed that pelagic schooling fish respond by vertical or lateral avoidance of approaching vessels (Mitson and Knudsen, 2003).

While disturbance/masking in fish and shellfish is possible during vessel operation, the effects of underwater noise emissions from vessel movement are likely to be small given the licensable activities will be temporary and will be undertaken within an operating port where background noise levels will already be elevated. There is also likely to be habituation associated with fish populations that occupy the port area and wider Waterway due to elevated background levels, therefore it is considered that the project is predicted to not result in the deterioration of fish communities and the WFD objectives of the waterbody restricted from being achieved by the project.

### 8.4.4 Biology- Marine Mammal (Priority Species)

The priority species include harbour porpoise, bottlenose dolphins, grey seals, and otters. As described in Section 3.5.1, occasional sightings of harbour porpoise and bottlenose dolphin have been recorded within the Waterway. The project has the potential to impact on these species through underwater noise emission from pile installation and vessel engine noise and collision from vessels.

The impact of noise varies depending the sound type and source as mentioned in Section 8.4.3. For marine mammals rotary drilling may cause disturbance up to 275 m and top drive drilling may cause disturbance up to 240 m. Neither PTS or TTS is expected to be experienced by any species.

Vessel noise can have behavioural effects on these marine mammals. Harbour porpoise, as one of the most hearing sensitive species, generally avoid vessels, whilst other species such as bottlenose dolphins, are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, bottlenose dolphins may also show avoidance behaviours such as increased swimming speed, spatial avoidance, increased group cohesion and longer dive duration (Miller *et al.*, 2008). Resting bottlenose dolphins are likely to avoid vessels, foraging bottlenose dolphins may ignore them, and socialising dolphins may approach vessels (Richardson *et al.*, 1995).

The area near the META Phase 1 Site 3 - Ferryside and within Pembroke Dock itself are not key areas for marine mammal species. Baseline data shows infrequent sightings of harbour porpoise and bottlenose dolphin within the Waterway with a low likelihood of occurrence as far up as the META Phase 1 Site 3 - Ferryside (Pembroke Dock). There may be otter activity in the area, although it is more likely that the shores in this area would be used as a resting area rather than as a key breeding site.

It is therefore considered highly unlikely that the installation of piles as well as noise from the support vessels will cause injury or disturbance to harbour porpoise and bottlenose dolphin populations within the waterway for the following reasons:

- The pile installation methods are unlikely to emit noise levels that could cause injury to marine mammal species;
- Marine mammal species would need to be in very close proximity (tens metres) to the pile installation, which is highly unlikely given the META Phase 1 Site 3 - Ferryside is located in an operating port where background noise levels are already elevated;
- Marine mammals are likely to avoid areas of increased anthropogenic noise; and
- Any animals that are disturbed are likely to recover quickly given the low level of noise predicted and therefore return to the area.

Movement of vessels supporting monopile or pontoon installation could lead to an increased risk of collision although most incidents are associated with vessel speeds of in excess of 14 knots. Vessels speeds will be <5 knots during the project due to port speed restrictions. Given the low vessel speed and low population numbers the potential for interaction is small. Therefore, no deterioration of this quality element is predicted and the objectives of the two water bodies restricted from being achieved.

### 8.4.5 Protected Areas

Within 2 km of the project footprint the following WFD protected areas are found:

- Pembrokeshire Marine/Sir Benfro Forol SAC (~150 m from project footprint)
- Shellfish waters (1,770 m from project footprint)

Impacts on features associated with Pembrokeshire Marine/Sir Benfro Forol SAC have been assessed as part of Section 7.1. Impacts to shellfish waters located 1,770 m are not predicted given the distance that shellfish waters are from the META Phase 1 Site 3 - Ferryside, and then nature, scale and duration of proposed activities to be supported at these sites.

No deterioration of the features of identified protected areas is expected from the META Phase 1 Site 3 - Ferryside activities.

## 9 SUMMARY

Overall, as displayed in Table 9.1, the impact of the installation of the pontoons at the META Phase 1 Site 3 - Ferryside has a largely negligible impact on the environment requiring no mitigation.

**Table 9.1: Summary of environmental impacts**

Description of receptor	Description of impact	Assessment of Effect
Physical Processes	Increases in suspended sediment concentrations from vessel movements	<b>Negligible</b>
	Changes to wave conditions from pontoon installation	<b>Negligible</b>
Benthic Ecology	Habitat disturbance/loss associated with monopile and pontoon installation	<b>Minor</b>
	Increases in suspended sediment concentrations	<b>Negligible</b>
Fish and Shellfish	Underwater noise effects from monopile installation	<b>Minor</b>
	Temporary habitat disturbance associated with pontoon installation	<b>Minor</b>
Marine Mammals	Underwater noise effects from monopile installation	<b>Negligible</b>
	Collision risk from vessel movements	<b>Negligible</b>
Shipping and Navigation	Restrictions to shipping and navigation from vessel activity	<b>Negligible</b>

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## Appendix A: Environmental Impact Scoping Exercise

A scoping exercise was carried out to inform the assessment, based on RPS's extensive experience in preparing similar assessments for comparable licensable activities. Activities, topics and impacts scoped out of the assessment are presented in Table A1 together with justification.

**Table A1 : Environmental topics and impacts scoped out of the assessment.**

Environmental Topic	Impact	Justification
Ornithology	All	Scoped out on the basis that whilst substantial marine bird populations have been found to the west of the Waterway (i.e., Skomer SPA), it is considered highly unlikely that the majority of marine birds will be found outside of their preferred habitat and feeding ranges which do not occur within the Waterway. Any marine birds such as gulls (Laridae) which are known to enter the Waterway, will be habituated to ongoing port operations within Pembroke Dock and are therefore considered unlikely to be adversely impacted by proposed licensable activities.
Commercial Fisheries	All	Scoped out on the basis that the licensable activities are located within Pembroke Dock and no commercial fishing activity is undertaken within the Port area, and therefore in or adjacent to META Phase 1 sites.
Marine Archaeology	All	Scoped out on the basis that no impact pathway for marine archaeology will be created as a result of increasing the size of the proposed pontoon and associated pile installation.
Infrastructure and other users	All	Scoped out on the basis that all proposed activities will be undertaken within an existing port area which restricts other users and activities.
Benthic Ecology	Release of sediment bound contaminants	Scoped out on the basis that the seabed that will be disturbed is already subject to regular disturbance as a result of port operations therefore installation of the pontoon will not cause any additional release of sediment bound contaminants. In addition, all material that will be drilled out, will be removed to the vessel and appropriate disposed of on land.
Benthic Ecology	Intertidal impacts	Scoped out on the basis that the impact footprint for the installation of the pontoon will be subtidal therefore no impacts to intertidal ecology are predicted.
Fish and Shellfish Ecology and Marine Mammals	Long term habitat associated with placement of pontoon	Scoped out on the basis that the pontoon installation will only create 11.6 m <sup>2</sup> of long-term habitat loss. This is a negligible area compared to the wider available habitat.
Shipping and Navigation	Reduced navigable water depth	Scoped out on the basis that the pontoon will float on top of the water and therefore not cause any reduction on navigable water depth.

## Appendix B: WFD Scoping Table

The scoping assessment for the project has been undertaken in accordance with NRW guidance note OGN072 (Table B1: WFD Scoping Table). Findings from the assessment have been undertaken with respect to two identified water bodies that could be potentially affected by the project:

- Milford Haven Inner is located within the project footprint; and
- Milford Haven outer is located approximately 2 km to the west of the project footprint.

**Table B1: WFD Scoping Table**

Your activity	Description, notes or more information
Applicant name	Pembrokeshire Coastal Forum
Application reference number (where applicable)	Not applicable
Name of activity	Change of methodology for pontoon installation
Brief description of activity	Installation of 10 monopiles to support the mooring of pontoon as part of the META phase 1 site (testing wave and tidal energy devices).
Location of activity (central point XY coordinates or national grid reference)	META Phase 1 Site 3 - Ferryside X: 51.697663 Y: -4.951354
Footprint of activity (ha)	Each monopile will have a seabed footprint of 1.16 m <sup>2</sup> with a total long term seabed footprint of 11.6 m <sup>2</sup> (0.00116 ha). Temporary habitat loss may also occur within the META Phase 1 Site 3 - Ferryside as a result of installation of the pontoon monopiles and associated jack up vessel events. One jack up event will be required for each monopile installation creating 112.24 m <sup>2</sup> of temporary habitat loss/disturbance as a result of jack up events (4.88 m <sup>2</sup> per jack up). The 1800 mm monopile casing are larger than the 1,220 mm monopiles and will be removed once the monopiles are installed, therefore an additional 1.38 m <sup>2</sup> of seabed per pile may be subject to temporary habitat disturbance during monopile installation. Resulting in 137.64 m <sup>2</sup> (0.00138 ha) of total temporary habitat loss. The pontoons will be 5 m x 25 m with a total area of 625 m <sup>2</sup> .
Timings of activity (including start and finish dates)	Works are expected to start in Q1 2022 and last for 60 days.

## META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL

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Extent of activity (for example size, scale frequency, expected volumes of output or discharge)

The activities involved in this project include the installation of piles and pontoons to support the deployment and retrieval of marine energy components/subassemblies on the seabed, within the water column or on the surface at the META Phase 1 Site 3 - Ferryside.

The installation of the piles is a variation from the original licence as extra moorings were determined to be required instead of the existing dolphins due to the wash expected from the ferries which dock at Pembroke Docks just west of the site.

There will be ten piles installed and five pontoons with the dimensions 5 m x 25 m (A-E).

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Use or release of chemicals (state which ones)

Grout/ Cement

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## Specific risk information

Potential risks of the updated methodology to the pontoon installation were considered for each of the following receptors: hydromorphology, biology (fish), water quality, priority habitats, priority species, INNS, and protected areas within each identified waterbody. Potential cumulative Impacts have also been assessed.

### Section 1: Hydromorphology

Consider if hydromorphology is at risk from your activity.

Use the water body summary table to find out the hydromorphology status of the water body, if it is classed as heavily modified and for what use (Table B2).

**Table B2: Waterbody assessment for Hydromorphology**

Consider if your activity:	Hydromorphology risk issue(s) to Milford Haven Inner Waterbody	Hydromorphology risk issue(s) to Milford Haven Outer Waterbody
Changes the physical form or alters the process of sediment transport (erosion, deposition, or transfer)	Yes; requires impact assessment. Potential for minor alterations to the process of sediment transport within the water.	No; impact assessment not required. The project will not affect the physical form or cause changes to sediment transport within the waterbody
Have a significant impact on the hydromorphology conditions of a waterbody, for example changes to: depth variation, the seabed and intertidal zone structure, tidal patterns, for example dominant currents, freshwater flow and wave exposure.	Yes; requires impact assessment. Deployment of components has the potential to cause minor changes to the hydrodynamic regime within the waterbody.	No; impact assessment not required. The project is not located within the waterbody any and will therefore not cause change to depth, the seabed or intertidal zone structure.
Has a physical footprint greater than 1% of the area of a surface water body or greater than 0.5km <sup>2</sup> , then it should be scoped in for hydromorphology	No; impact assessment not required. The physical footprint of the project will comprise of <1% of the area of both identified waterbodies and constitutes an area of 0.000137 km <sup>2</sup> .	No; impact assessment not required. The physical footprint of the project is located outside the waterbody and therefore will not impact on waterbody
Is in a water body that is heavily modified for the same use as your activity	No; impact assessment not required. Both identified waterbodies are not considered as heavily modified in accordance with extracted data.	No; impact assessment not required. Both identified waterbodies are not considered as heavily modified in accordance with extracted data.

## Section 2: Water quality

A scoping assessment has been undertaken on water quality and how physicochemical parameters could be affected by the project is provided in the table below (Table B3)

**Table B3: Waterbody assessment for water quality**

Consider if your activity:	Water quality risk issue(s) to Milford Haven Inner Waterbody	Water quality risk issue(s) to Milford Haven Outer Waterbody
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	No. Impact assessment not required Sediment plumes generated by pile installation will not extend for more than a few hours following operation.	No. Impact assessment not required Sediment plumes generated by installation of pontoons will be localised and not be continuous for a period of more than 14 days and will not impact on waterbody.
Is in a water body with a phytoplankton status of moderate, poor or bad	No. Impact assessment not required Waterbody is classified as high	No. Impact assessment not required Waterbody is classified as high
Is in a water body with a history of harmful algae	No. Impact assessment not required Not previously monitored	No. Impact assessment not required Not previously monitored

**META PHASE 1 SITES MARINE LICENCE VARIATION ENVIRONMENTAL APPRAISAL**

Potential for release or disturbance of chemicals has been considered in the table below (Table B.4):

**Table B.4: Chemical disturbance risk assessment**

<b>If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if:</b>	<b>Water quality risk issue(s) to Milford Haven Inner Waterbody</b>	<b>Water quality risk issue(s) to Milford Haven Outer Waterbody</b>
The chemicals are on the Environmental Quality Standards Directive (EQSD) list	No. Impact assessment not required Use of chemicals is not predicted during project.	No. Impact assessment not required Use of chemicals is not predicted during project.
It disturbs sediment with contaminants above Cefas Action Level 1	No. Impact assessment not required Small, localised disturbance of sediments is predicted from installation of the pontoons although it is not considered that contaminants will be released from sediments as part of these activities given the small scale, or temporary nature of disturbance events.	No. Impact assessment not required Small, localised disturbance of sediments is predicted from installation of the pontoons although it is not considered that contaminants will be released from sediments as part of these activities given the small scale, or temporary nature of disturbance events.
<b>If your activity has a mixing zone (like a discharge pipeline or outfall) consider if:</b>	<b>Water quality risk issue(s) to Milford Haven Inner Waterbody</b>	<b>Water quality risk issue(s) to Milford Haven Outer Waterbody</b>
The chemicals released are on the Environmental Quality Standards Directive (EQSD) list	No. Impact assessment not required The project will not have a mixing zone associated with the activity and therefore no chemicals listed on Environmental Quality Standards Directive (EQSD) list that will be released as part of the project activities.	No. Impact assessment not required The project will not have a mixing zone associated with the activity and therefore no chemicals listed on Environmental Quality Standards Directive (EQSD) list that will be released as part of the project activities.

### Section 3: Biology

Annex V of the Directive sets out Biological Quality Elements (BQEs) which are used to classify ecological status using five classes from high to bad including elements such as fish, invertebrates, or algae (Table B5).

**Table B5: Ecological classification summary**

Quality Element	Pressure Description
Phytoplankton	Nutrient enrichment
Macroalgae	Nutrient enrichment, hazardous chemicals
Angiosperms	Nutrient enrichment, morphological alterations
Benthic invertebrates	Organic pollution, hazardous chemicals and some morphological alterations
Fish (transitional only)	Organic enrichment (dissolved oxygen), habitat destruction

Following consideration of the proposed project activities and the pressure descriptions for each receptor, of the quality elements **only benthic invertebrates and fish** have been taken forward for further assessment for the Milford Haven Inner water way. No impacts to Milford Haven Outer are predicted. The project will not cause nutrient enrichment of the waterbody that could potentially impact on phytoplankton.

### Section 3: Fish

A scoping assessment has been undertaken on whether fish could be potentially affected by the project and the results are provided in the table below (Table B6):

**Table B6: Waterbody assessment for fish**

Consider if your activity:	Biology fish risk issue(s) to Milford Haven Inner Waterbody	Biology fish risk issue(s) to Milford Haven Outer Waterbody
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)	Yes; requires impact assessment. Underwater noise effects during pile installation and vessel movements and operation have the potential to cause disturbance effects to fish.	No. Impact assessment not required Disturbance to fish within waterbody is not expect given all disturbance will be localised to within the project area.
Could cause mechanical injury or death to fish through: Entrainment, e.g., fish being drawn into cooling water systems or turbines Impingement, e.g., fish trapped against debris screens	No; impact assessment not required. There are no intakes associated with the project that could cause entrainment or impingement to fish within the waterbody. All moving parts are considered to move at speeds which will not cause collision to fish species.	No; impact assessment not required. The project is not located within the waterbody and therefore no mechanical injury is predicted to fish within the waterbody.

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Is in a transitional water body and could affect fish or is outside of the transitional water body but could impact upon migratory fish	Yes; requires impact assessment. Project footprint is located within the Milford Haven Inner Waterbody which is characterised as transitional	Yes; requires impact assessment. Project could potentially impact migratory fish associated with the waterbody.
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**Section 4: WFD protected areas**

An assessment of the following WFD protected areas have been considered at risk if they are located within located 2 km of the project footprint (Table B7):

- special areas of conservation (SAC)
- special protection areas (SPA)
- shellfish waters
- bathing waters
- nutrient sensitive areas

**Table B7: Location of Waterbodies within 2 km**

Consider if your activity is:	Protected areas risk issue(s)
Within 2km of any WFD protected area	Within 2km of the project footprint the following WFD protected areas are found: 1. Pembrokeshire Marine/Sir Benfro Forol SAC (~150 m from project footprint) 2. Shellfish waters (1,770 m from project footprint) (NRW, 2013) No other WFD protected areas are located within 2km of the project footprint.

## Section 5: Priority habitats and species

An assessment of whether the project to cause impacts on priority habitats and species under Environment (Wales) Act 2016 (Table B8).

**Table B8: Waterbody assessment on priority habitats**

Consider if:	Priority species and habitat risk associated with Milford Haven Inner Waterbody	Priority species and habitat risk associated with Milford Haven Outer Waterbody
There are priority species and habitats within identified waterbody	Yes. Several listed migratory and non-migratory fish species as well as harbour porpoise, bottlenose dolphins, grey seals and otters, may occur within the waterbody. Several listed habitats also occur.	Yes. Several listed migratory and non-migratory fish species and harbour porpoise may occur within the waterbody. Several listed habitats also occur
Consider if the project could:	Priority species and habitat risk associated with Milford Haven Inner Waterbody	Priority species and habitat risk associated with Milford Haven Outer Waterbody
Impact on identified priority species	Yes; requires impact assessment. Underwater noise effects during pile installation and vessel movements have the potential to cause disturbance to fish and harbour porpoise. Collision risk to marine mammal species from vessel movements	No; impact assessment not required. Project activities will not impact on the priority habitats within the waterbody.
Impact on identified priority habitats	No; requires impact assessment. Project activities will not impact on priority habitats within the waterbody.	No; impact assessment not required. Project activities will not impact on the priority habitats within the waterbody.

## Section 6: Invasive non-native species

An assessment was undertaken to determine whether the project could introduce or spread INNS (Table B9).

Risks of introducing or spreading INNS include:

- materials or equipment that have come from, had use in or travelled through other water bodies
- activities that help spread existing INNS, either within the immediate water body or other water bodies

**Table B9: Waterbody assessment on INNS**

Consider if your activity could:	INNS risk issue(s)
Introduce or spread INNS	No: The support vessel that will transit to site from within the Waterbodies. In addition, there will be a MPCP and a INNMP in place.

## Section 7: Summary

A summary of the results of the scoping assessment on the Milford Haven Inner and outer waterway are provided below (Table B10):

**Table B10: Waterbody assessment summary**

Receptor	Waterbody	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	Milford Haven Inner	Yes	Potential for minor alteration to the process of sediment transport within the waterbody. Deployment of components has the potential to cause minor changes to the hydrodynamic regime within the waterbody.
	Milford Haven Outer	No	The project will not affect the physical form or cause changes to sediment transport within the waterbody, depth or intertidal zone structure.
Biology	Milford Haven Inner	Yes	No potential impacts are predicted to biological quality elements.
	Milford Haven Outer	No	No potential impacts are predicted to biological quality elements.
Fish	Milford Haven Inner	Yes	Underwater noise effects during vessel movements and operation have the potential to cause disturbance to fish.
	Milford Haven Outer	Yes	Underwater noise effects during vessel movements and operation have the potential to cause disturbance on migratory fish associated with the waterbody.

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<b>Receptor</b>	<b>Waterbody</b>	<b>Potential risk to receptor?</b>	<b>Note the risk issue(s) for impact assessment</b>
Water quality	Milford Haven Inner	No	Sediment plumes generated by propeller wash and pile installation that cause changes to water clarity will not extend for more than a few hours following operation and not continuously for a spring tidal cycle.
	Milford Haven Outer	No	As above
Protected areas	Milford Haven Inner	Yes	Within 2 km of the project footprint the following protected areas are found: Pembrokeshire Marine/Sir Benfro Forol SAC (180 m from project footprint) Shellfish waters (1770 m from project footprint)
	Milford Haven Outer	Yes	As above
Priority Habitats and Species	Milford Haven Inner	Yes	Several listed migratory and non-migratory fish species, harbour porpoise, and listed habitats may occur within the waterbody. Underwater noise effects during vessel movements and operation have the potential to cause disturbance to migratory fish and harbour porpoise.
	Milford Haven Outer	Yes	Several listed migratory and non-migratory fish species, harbour porpoise, and listed habitats may occur within the waterbody. Underwater noise effects during vessel movements and operation have the potential to cause disturbance to migratory fish and harbour porpoise.
Invasive non-native species	Milford Haven Inner	No	The support vessel that will be transported to site from within the Waterbodies.
	Milford Haven Outer	No	As above

## Appendix C: Subsea noise modelling report

# Marine Energy Test Area (META) Pile Installation

Subsea Noise Modelling



## Document Control

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# 1 Introduction

RPS is currently supporting Pembroke Dock in seeking a variation to the Marine Energy Test Areas (META) marine licence for their Phase 1 sites in Milford Haven to include the installation of monopiles to support a new pontoon at one of the test sites within Pembroke Dock (Ferryside; site 3). The existing marine licence, and the supporting environmental appraisal, assumed that the pontoon would be installed on existing piles and there would be no requirement for piling. The contractor has subsequently identified that the existing pontoons will not be sufficient and have developed a revised design. In order to install the ten monopiles it is proposed to use either a rotary system or top drilled piling, which would not involve any significant impact or percussion.

The location of the proposed monopiles is illustrated in Figure 1.1.

Noise is readily transmitted underwater and there is potential for sound emissions from the survey to affect marine mammals and fish. At long ranges the introduction of additional noise could potentially cause short-term behavioural changes, for example to the ability of species to communicate and to determine the presence of predators, food, underwater features, and obstructions. At close ranges and with high noise source levels, permanent or temporary hearing damage may occur, while at very close range, gross physical trauma is possible. This report provides an overview of the potential effects due to underwater noise from the survey on the surrounding marine environment.

The primary purpose of this underwater noise study is to predict the likely range of onset for potential injury (i.e. permanent threshold shifts in hearing) and behavioural effects.

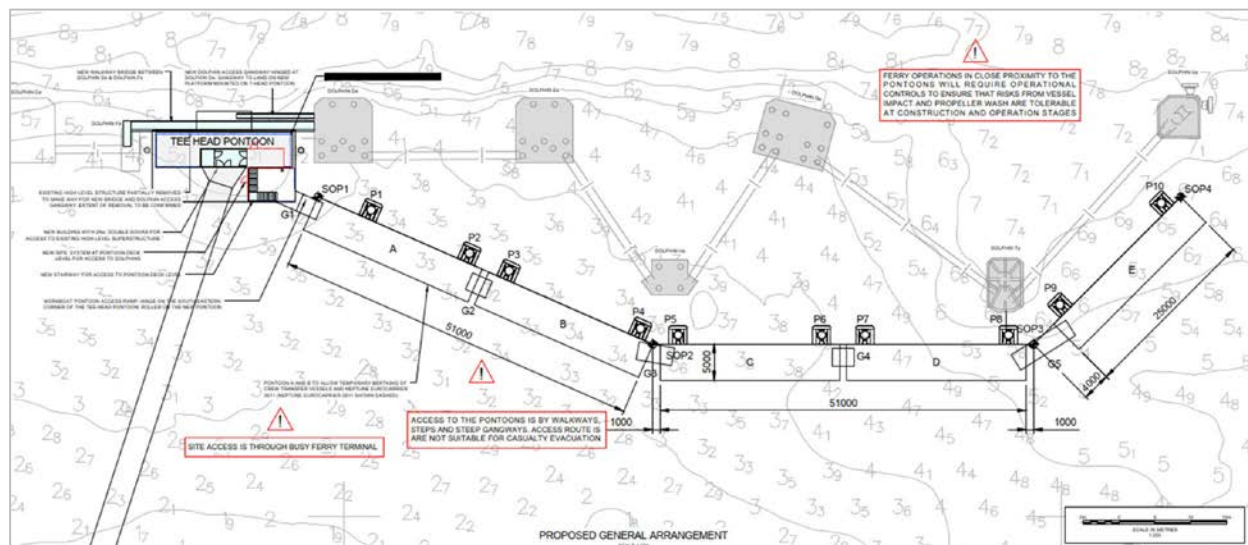
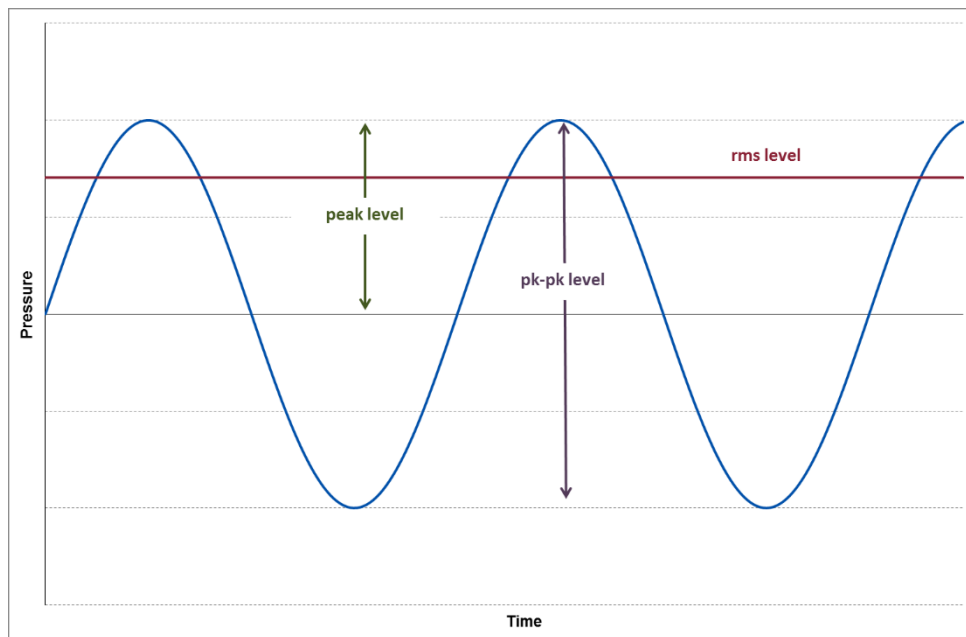


Figure 1.1: Pontoon and pile locations

## 2 Acoustic Concepts and Terminology

Sound travels through the water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure) and rarefactions (negative pressure). Because sound consists of variations in pressure, the unit for measuring sound is usually referenced to a unit of pressure, the Pascal (Pa). The decibel (dB) scale is used to conveniently communicate the large range of acoustic pressures encountered, with a known pressure amplitude chosen as a reference value (i.e., 0 dB). In the case of underwater sound, the reference value ( $P_{ref}$ ) is taken as 1  $\mu\text{Pa}$ , whereas the airborne sound is usually referenced to a pressure of 20  $\mu\text{Pa}$ . To convert from a sound pressure level referenced to 20  $\mu\text{Pa}$  to one referenced to 1  $\mu\text{Pa}$ , a factor of  $20 \log(20/1)$  i.e., 26 dB has to be added to the former quantity. Thus 60 dB re 20  $\mu\text{Pa}$  is the same as 86 dB re 1  $\mu\text{Pa}$ , although differences in sound speeds and different densities mean that the decibel level difference in sound intensity is much more than the 26 dB when converting pressure from air to water. All underwater sound pressure levels in this report are quantified in dB re 1  $\mu\text{Pa}$ .

There are several descriptors used to characterise a sound wave. The difference between the lowest pressure variation (rarefaction) and the highest-pressure variation (compression) is called the peak to peak (or pk-pk) sound pressure level. The difference between the highest variation (either positive or negative) and the mean pressure is called the peak pressure level. Lastly, the root mean square (rms) sound pressure level is used as a description of the average amplitude of the variations in pressure over a specific time window. Decibel values reported should always be quoted along with the  $P_{ref}$  value employed during calculations. For example, the measured  $\text{SPL}_{rms}$  value of a pulse may be reported as 100 dB re 1  $\mu\text{Pa}$ . These descriptions are shown graphically in Figure 2.1.



**Figure 2.1: Graphical representation of acoustic wave descriptors**

The rms sound pressure level (SPL) is defined as follows:

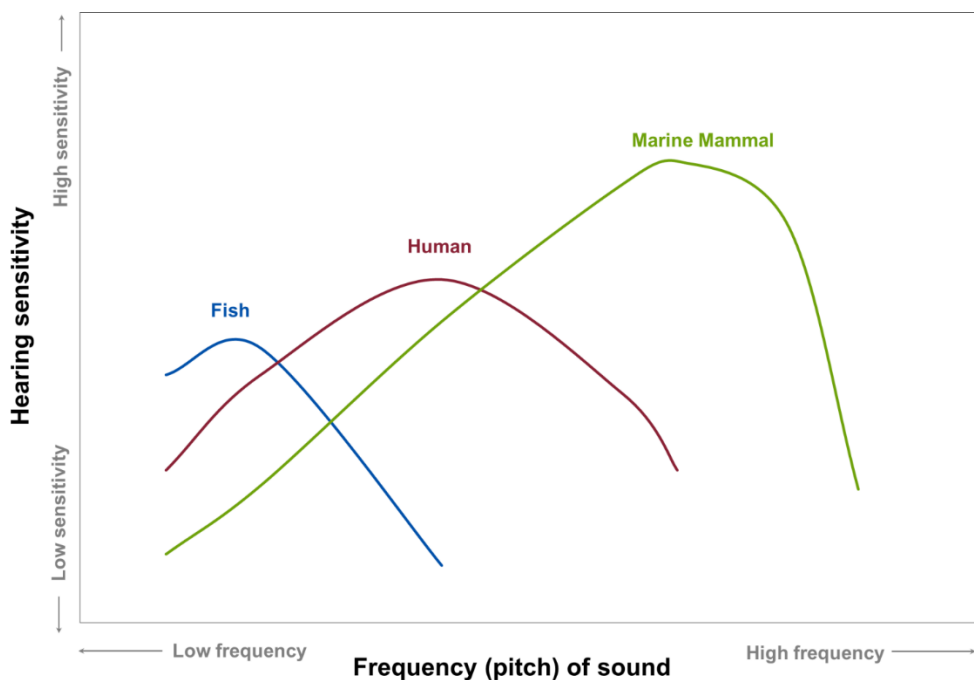
$$\text{SPL}_{rms} = 10 \log_{10} \left( \frac{1}{T} \int_0^T \left( \frac{p^2}{p_{ref}^2} \right) dt \right)$$

The magnitude of the rms sound pressure level for an impulsive sound (such as that from a seismic source array) will depend upon the integration time,  $T$ , used for the calculation (Madsen 2005). It has become customary to utilise the T90 time period for calculating and reporting rms sound pressure levels. This is the interval over which the cumulative energy curve rises from 5% to 95% of the total energy and therefore contains 90% of the sound energy.

Another useful measure of sound used in underwater acoustics is the Sound Exposure Level, or SEL. This descriptor is used as a measure of the total sound energy of an event or a number of events (e.g., over the course of a day) and is normalised to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis<sup>1</sup>. The SEL is defined as follows:

$$SEL = 10 \log_{10} \left( \int_0^T \left( \frac{p^2(t)}{p_{ref}^2 t_{ref}} \right) dt \right)$$

The frequency, or pitch, of the sound is the rate at which the acoustic oscillations occur in the medium (air/water) and is measured in cycles per second, or Hertz (Hz). When sound is measured in a way which approximates to how a human would perceive it using an A-weighting filter on a sound level meter, the resulting level is described in values of dBA. However, the hearing faculty of marine mammals is not the same as humans, with marine mammals hearing over a wider range of frequencies and with a different sensitivity. It is therefore important to understand how an animal's hearing varies over its entire frequency range to assess the effects of anthropogenic sound on marine mammals. Consequently, use can be made of frequency weighting scales (m-weighting) to determine the level of the sound in comparison with the auditory response of the animal concerned. A comparison between the typical hearing response curves for fish, humans and marine mammals is shown in Figure 2.2. (It is worth noting that hearing thresholds are sometimes shown as audiograms with sound level on the y-axis rather than sensitivity, resulting in the graph shape being the inverse of the graph shown.)



**Figure 2.2: Comparison between hearing thresholds of different animals**

Other relevant acoustic terminology and their definitions used in the report are detailed below.

### **1/3<sup>rd</sup> octave bands**

The broadband acoustic power (i.e., containing all the possible frequencies) emitted by a sound source, measured/modelled at a location within the survey region is generally split into and reported in a series of frequency bands. In marine acoustics, the spectrum is generally reported in standard 1/3<sup>rd</sup> octave band frequencies, where an octave represents a doubling in sound frequency.

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*1 Historically, use was primarily made of rms and peak sound pressure level metrics for assessing the potential effects of sound on marine life. However, the SEL is increasingly being used as it allows exposure duration and the effect of exposure to multiple events to be considered.*

### **Source level (SL)**

The source level is the sound pressure level of an equivalent and infinitesimally small version of the source (known as *point source*) at a hypothetical distance of 1 m from it. The source level may be combined with the transmission loss (TL) associated with the environment to obtain the received level (RL) in the *far field* of the source. The far field distance is chosen so that the behaviour of the distributed source can be approximated to that of a point source. Source levels do not indicate the real sound pressure level at 1 m.

### **Transmission loss (TL)**

TL at a frequency of interest is defined as the loss of acoustic energy as the signal propagates from a hypothetical (point) source location to the chosen receiver location. The TL is dependent on water depth, source depth, receiver depth, frequency, geology, and environmental conditions. The TL values are generally evaluated using an acoustic propagation model (various numerical methods exist) accounting for the above dependencies.

### **Received level (RL)**

The RL is the sound level of the acoustic signal recorded (or modelled) at a given location, that corresponds to the acoustic pressure/energy generated by a known active sound source. This considers the acoustic output of a source and is modified by propagation effects. This RL value is strongly dependant on the source, environmental properties, geological properties and measurement location/depth. The RL is reported in dB either in rms or peak-to-peak SPL, and SEL metrics, within the relevant third-octave band frequencies. The RL is related to the SL as

$$RL = SL - TL$$

where TL is the transmission loss of the acoustic energy within the survey region.

The directional dependence of the source signature and the variation of TL with azimuthal direction  $\alpha$  (which is strongly dependent on bathymetry) are generally combined and interpolated to report a 2-D plot of the RL around the chosen source point up to a chosen distance.

# 3 Acoustic Assessment Criteria

## 3.1 Introduction

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson et al. (1995) defined four zones of noise influence which vary with distance from the source and level. These are:

- **The zone of audibility:** this is the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will have an effect on the marine mammal.
- **The zone of masking:** this is defined as the area within which noise can interfere with detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall noise level).
- **The zone of responsiveness:** this is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller than the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction.
- **The zone of injury / hearing loss:** this is the area where the sound level is high enough to cause tissue damage in the ear. This can be classified as either temporary threshold shift (TTS) or permanent threshold shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g., underwater explosions), physical trauma or even death are possible.

For this study, it is the zones of injury and disturbance (i.e., responsiveness) that are of concern (there is insufficient scientific evidence to properly evaluate masking). To determine the potential spatial range of injury and disturbance, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them.

## 3.2 Marine Mammals

Sound propagation models can be constructed to allow the received noise level at different distances from the source to be calculated. To determine the consequence of these received levels on any marine mammals which might experience such noise emissions, it is necessary to relate the levels to known or estimated impact thresholds. The injury criteria proposed by Southall et al (2019). are based on a combination of linear (i.e., un-weighted) peak pressure levels and mammal hearing weighted sound exposure levels (SEL). The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects. The categories include:

- **low-frequency (LF) cetaceans** (i.e., marine mammal species such as baleen whales);
- **high-frequency (HF) cetaceans** (i.e., marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales);
- **very high-frequency (VHF) cetaceans** (i.e., marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz);
- **phocid pinnipeds (PCW)** (i.e., true seals; hearing in air is considered separately in the group PCA); and
- **other marine carnivores (OCW)** (including otariid pinnipeds (e.g., sea lions and fur seals), sea otters and polar bears; air hearing considered separately in the group OCA).

These weightings have therefore been used in this study and are shown in Figure 3.1.

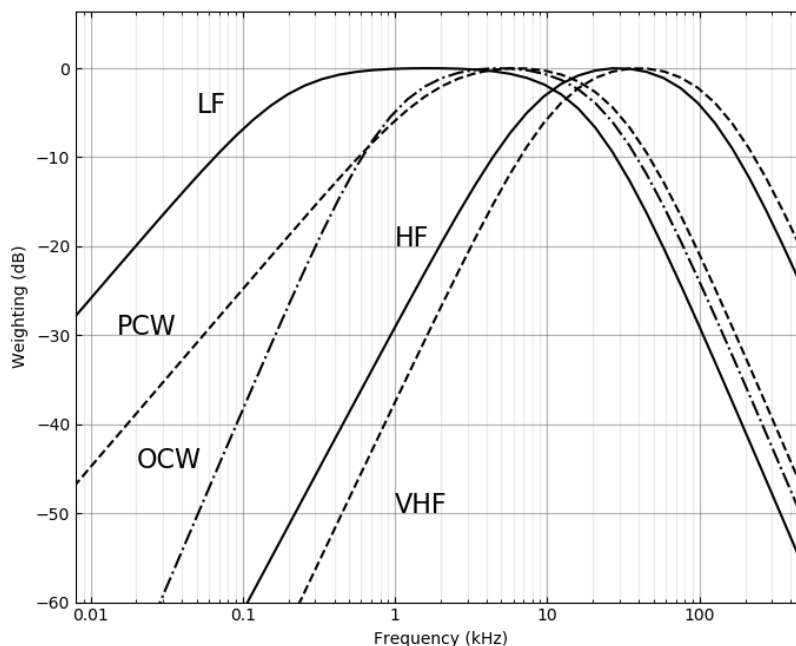


Figure 3.1: Hearing weighting functions for pinnipeds and cetaceans (Southall et al. 2019)

Injury criteria are proposed in Southall et al (2019) are for two different types of sound as follows:

- **Impulsive sounds** which are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI 1986; NIOSH 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions; and
- **Non-impulsive sounds** which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous running machinery, sonar and vessels.

The relevant criteria proposed by Southall et al. (2019) are as summarised in Table 3.1. Only the thresholds for non-impulsive sound are shown due to the nature of the piling activity proposed for the project which will use either rotary piling or top drilled piles.

Table 3.1: Summary of PTS onset acoustic thresholds (Southall et al. 2019)

Hearing Group	Parameter	Non-impulsive	
		PTS	TTS
Low-frequency (LF) cetaceans	Peak, unweighted	-	
	SEL, LF weighted	199	179
High-frequency (HF) cetaceans	Peak, unweighted	-	
	SEL, MF weighted	198	178
Very High-frequency (VHF) cetaceans	Peak, unweighted	-	
	SEL, HF weighted	173	153
Phocid Carnivores in Water (PCW)	Peak, unweighted	-	
	SEL, PW weighted	201	181
Other Marine Carnivores in Water (OCW)	Peak, unweighted	-	
	SEL, OW weighted	219	199

These updated marine mammal injury criteria were published in March 2019 (Southall et al. 2019). The paper utilised the same hearing weighting curves and thresholds as presented in the preceding regulations document (NMFS 2018) with the main difference being the naming of the hearing groups and introduction of additional thresholds for animals not covered by NMFS (2018). A comparison between the two naming conventions is shown in Table 3.2.

For avoidance of doubt, the naming convention used in this report is based upon those set out in Southall et al. (2019). Consequently, this assessment utilises criteria which are applicable to both NMFS (2018) and Southall et al. (2019).

**Table 3.2: Comparison of hearing group names between NMFS 2018 and Southall 2019**

NMFS (2018) hearing group name	Southall et al. (2019) hearing group name
Low frequency cetaceans (LF)	Low-frequency cetaceans (LF)
Mid frequency cetaceans (MF)	High-frequency cetaceans (HF)
High frequency cetaceans (HF)	Very high-frequency cetaceans (VHF)
Phocid pinnipeds in water (PW)	Phocid carnivores in water (PCW)

In order to assess potential disturbance to marine mammals, criteria for impulsive and non-impulsive sounds are based on NMFS (2005) and HESS (1997). The criteria are as follows:

- Potential disturbance due to non-impulsive sound: 120 dB re 1  $\mu$ Pa (rms)

### 3.3 Fish

Adult fish not in the immediate vicinity of the noise generating activity are generally able to vacate the area and avoid physical injury. However, larvae and eggs are not highly mobile and are therefore more likely to incur injuries from the sound energy in the immediate vicinity of the sound source, including damage to their hearing, kidneys, hearts and swim bladders. Such effects are unlikely to happen outside of the immediate vicinity of even the highest energy sound sources.

For fish, the most relevant criteria for injury are considered to be those contained in the recent Sound Exposure Guidelines for Fishes and Sea Turtles (Popper et al. 2014). These guidelines do not group by species but instead broadly group fish into the following categories based on their anatomy and the available information on hearing of other fish species with comparable anatomies:

- **Group 1 fish:** fishes with no swim bladder or other gas chamber (e.g. elasmobranchs, flatfishes and lampreys). These species are less susceptible to barotrauma and are only sensitive to particle motion, not sound pressure. Basking shark, which does not have a swim bladder, falls into this hearing group;
- **Group 2 fish:** fishes with swim bladders but the swim bladder does not play a role in hearing (e.g. salmonids). These species are susceptible to barotrauma, although hearing only involves particle motion, not sound pressure;
- **Group 3:** Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than groups 1 and 2, extending to about 500 Hz;
- **Group 4:** Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring, sprat and shads). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3;
- **Sea Turtles:** There is limited information on auditory criteria for sea turtles and the effect of impulsive noise is therefore inferred from documented effects to other vertebrates. Bone conducted hearing is the most likely mechanism for auditory reception in sea turtles and, since high frequencies are attenuated by bone, the range of hearing are limited to low frequencies only (Tonndorf, 1972). For

leatherback turtle the hearing range has been recorded as between 50 and 1,200 Hz with maximum sensitivity between 100 and 400 Hz (Piniak, 2012); and

- **Fish eggs and larvae.**

The guidelines set out criteria for injury due to different sources of noise. Those relevant to the proposed activities are considered to be those for injury due to continuous sound. Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different noise levels and therefore all sources of noise, no matter how noisy, would theoretically elicit the same assessment result. However, because the qualitative risks are generally qualified as “low”, with the exception of a moderate risk at “near” range (i.e. within tens of metres) for some types of animal and impairment effects, this is not considered to be a significant issue with respect to determining the potential effect of noise on fish.

The criteria used in this noise assessment for rotary and top-drive drilled (non-impulsive) piling are given in Table 3.4.

**Table 3.3: Criteria for onset of injury to fish and sea turtles due to non-impulsive sound (Popper et al., 2014).**

Type of animal	Mortality and potential mortal injury	Recoverable injury	TTS
Group 1 Fish: no swim bladder (particle motion detection)	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	(Near) Low (Intermediate) Low (Far) Low	170 dB re 1 µPa (rms) for 48 hours	158 dB re 1 µPa (rms) for 12 hours
Sea turtles	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Eggs and larvae	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low

Behavioural reaction of fish to sound has been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish’s body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders<sup>2</sup>.

Highly sensitive species such as herring have elaborate specialisations of their auditory apparatus, known as an otic bulla – a gas-filled sphere, connected to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies

<sup>2</sup> It should be noted that the presence of a swim bladder does not necessarily mean that the fish can detect pressure. Some fish have swim bladders that are not involved in the hearing mechanism and can only detect particle motion.

and as such are considered to be of medium sensitivity to noise. Flat fish and elasmobranchs have no swim bladders and as such are considered to be relatively less sensitive to sound pressure.

The most recent criteria for disturbance are considered to be those contained in Popper et al. (2014) which set out criteria for disturbance due to different sources of noise. The risk of behavioural effects is categorised in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres), as shown in Table 3.5.

**Table 3.4: Criteria for onset of behavioural effects in fish and sea turtles for non-impulsive sound (Popper et al., 2014).**

Type of animal	Relative risk of behavioural effects
Group 1 Fish: no swim bladder (particle motion detection)	(Near) Moderate (Intermediate) Moderate (Far) Low
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) Moderate (Intermediate) Moderate (Far) Low
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	(Near) High (Intermediate) Moderate (Far) Low
Sea turtles	(Near) High (Intermediate) Moderate (Far) Low
Eggs and larvae	(Near) Moderate (Intermediate) Moderate (Far) Low

The Popper et al. (2014) criteria for disturbance due to sound are qualitative rather than quantitative. Consequently, a source of noise of a particular type (e.g. piling) would result in the same predicted impact, no matter the level of noise produced or the propagation characteristics.

# 4 Assessment Methodology

## 4.1 Source Levels

Underwater noise sources are usually quantified in dB re 1  $\mu$ Pa, as if measured at a hypothetical distance of 1 m from the source (the Source Level). In practice, it is not usually possible to measure at 1 m from a source, but this metric allows comparison and reporting of different source levels on a like-for-like basis. In reality, for a large sound source this imagined point at 1 m from the acoustic centre does not exist. Furthermore, the energy is distributed across the source and does not all emanate from this imagined acoustic centre point. Therefore, the stated sound pressure level at 1 m does not actually occur for large sources. In the acoustic near-field (i.e. close to the source), the sound pressure level will be significantly lower than the value predicted by the source level.

For rotary drilled piling, source sound levels have been based on pile drilling for the Oyster 800 project (Kongsberg 2011).

The top drilled pile source sound levels are based on pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford lough (Nedwell and Brooker 2008). The source levels used in the assessment are summarised in Table 4.1.

**Table 4.1: Piling noise source levels used in assessment (un-weighted).**

Parameter	Source level at 1 m
<b>Rotary Drilled Piling</b>	
SEL per second of operation @ 1 m, dB re 1 $\mu$ Pa <sup>2</sup> s	163
Peak sound pressure level @ 1 m, dB re 1 $\mu$ Pa	166
rms <sub>T90</sub> sound pressure level @ 1 m, dB re 1 $\mu$ Pa	163
<b>Top Drive Drilled Piling</b>	
SEL per second of operation @ 1 m, dB re 1 $\mu$ Pa <sup>2</sup> s	162
Peak sound pressure level @ 1 m, dB re 1 $\mu$ Pa	165
rms <sub>T90</sub> sound pressure level @ 1 m, dB re 1 $\mu$ Pa	162

## 4.2 Propagation Model

As distance from the sound source increases the level of sound reduces, primarily due to the spreading of the sound energy with distance, in combination with attenuation due to absorption of sound energy by molecules in the water. This latter mechanism is more important for higher frequency sound than for lower frequencies.

The way that the sound spreads (geometrical divergence) will depend upon several factors such as water column depth, pressure, temperature gradients, salinity as well as water surface and bottom (i.e. seabed) conditions. Thus, even for a given locality, there are temporal variations to the way that sound will propagate. In simple terms, the sound energy may spread out in a spherical pattern (close to the source) or a cylindrical pattern (much further from the source), although other factors mean that decay in sound energy may be somewhere between these two simplistic cases.

In acoustically shallow waters<sup>3</sup> in particular, the propagation mechanism is coloured by multiple interactions with the seabed and the water surface (Lurton 2002; Etter 2013; Urlick 1983; Brekhovskikh and Lysanov

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<sup>3</sup> Acoustically, shallow water conditions exist whenever the propagation is characterised by multiple reflections with both the sea surface and bottom (Etter 2013). Consequently, the depth at which water can be classified as acoustically deep or shallow depends upon numerous factors including the sound speed gradient, water depth, frequency of the sound and distance between the source and receiver.

2014; Kinsler et al., 1999). Whereas in deeper waters, the sound will propagate further without encountering the surface or bottom of the sea, in shallower waters the sound may be reflected from either or both boundaries (potentially more than once).

At the sea surface, the majority of sound is reflected back into the water due to the difference in acoustic impedance (i.e. sound speed and density) between air and water. However, scattering of sound at the surface of the sea can be an important factor with respect to the propagation of sound. In an ideal case (i.e. for a perfectly smooth sea surface), the majority of sound energy will be reflected back into the sea. However, for rough seas, much of the sound energy is scattered (e.g. Eckart 1953; Fortuin 1970; Marsh, Schulkin, and Kneale 1961; Urick and Hoover 1956). Scattering can also occur due to bubbles near the surface such as those generated by wind or fish or due to suspended solids in the water such as particulates and marine life. Scattering is more pronounced for higher frequencies than for low frequencies and is dependent on the sea state (i.e. wave height). However, the various factors affecting this mechanism are complex.

Because surface scattering results in differences in reflected sound, its effect will be more important at longer ranges from the sound source and in acoustically shallow water (i.e. where there are multiple reflections between the source and receiver). The degree of scattering will depend upon the sea state/wind speed, water depth, frequency of the sound, temperature gradient, grazing angle and range from source. It should be noted that variations in propagation due to scattering will vary temporally within an area primarily due to different sea-states / wind speeds at different times. However, over shorter ranges (e.g. several hundred meters or less) the sound will experience fewer reflections and so the effect of scattering should not be significant.

When sound waves encounter the bottom, the amount of sound reflected will depend on the geoacoustic properties of the bottom (e.g. grain size, porosity, density, sound speed, absorption coefficient and roughness) as well as the grazing angle and frequency of the sound (Cole 1965; Hamilton 1970; Mackenzie 1960; McKinney and Anderson 1964; Etter 2013; Lurton 2002; Urick 1983). Thus, bottoms comprising primarily mud or other acoustically soft sediment will reflect less sound than acoustically harder bottoms such as rock or sand. This will also depend on the profile of the bottom (e.g. the depth of the sediment layer and how the geoacoustic properties vary with depth below the sea floor). The effect is less pronounced at low frequencies (a few kHz and below). A scattering effect (similar to that which occurs at the surface) also occurs at the bottom (Essen 1994; Greaves and Stephen 2003; McKinney and Anderson 1964; Kuo 1992), particularly on rough substrates (e.g. pebbles).

Waveguide effect should also be considered, which defines the shallow water columns do not allow the propagation of low frequency sound (Urick 1983; Etter 2013). The cut-off frequency of the lowest mode in a channel can be calculated based on the water depth and knowledge of the sediment geoacoustic properties. Any sound below this frequency will not propagate far due to energy losses through multiple reflections.

Sound speed gradient is the final piece of the puzzle. Changes in the water temperature and the hydrostatic pressure with depth imply that the speed of sound varies throughout the water column. This can lead to significant variations in sound propagation and can also lead to sound channels, particularly for high frequency sound. Sound can propagate in a duct-like manner within these channels, effectively focussing the sound, and conversely they can also lead to shadow zones. The frequency at which this occurs depends on the characteristics of the sound channel. The temperature gradient can vary throughout the year and thus there will be potential variation in sound propagation depending on the season.

Sound energy is also absorbed due to interactions at the molecular level converting the acoustic energy into heat. This is another frequency dependent effect with higher frequencies experiencing much higher losses than lower frequencies.

#### 4.2.1 Modelling approach

There are several methods available for modelling the propagation of sound between a source and receiver ranging from very simple models which simply assume spreading according to a  $10 \log(R)$  or  $20 \log(R)$  relationship (for cylindrical or spherical spreading respectively, as discussed above) to full acoustic models (e.g. ray tracing, normal mode, parabolic equation, wavenumber integration and energy flux models). In

addition, semi-empirical models are available which lie somewhere in between these two extremes in terms of complexity.

In choosing which propagation model to employ, it is important to ensure that it is fit for purpose and produces results with a suitable degree of accuracy for the application in question, taking into account the context (as detailed in NPL Guidance and Farcas et al., 2016). Thus, in some situations (e.g. low risk due to underwater noise, range dependent bathymetry is not an issue, non-impulsive sound) a simple (N log R) model will be sufficient, particularly where other uncertainties outweigh the uncertainties due to modelling. On the other hand, some situations (e.g. high source levels, impulsive sound, complex source and propagation path characteristics, highly sensitive receivers and low uncertainties in assessment criteria) warrant a more complex modelling methodology.

The first step in choosing a propagation model is therefore to examine these various factors, such as set out below:

- balancing of errors / uncertainties;
- range dependant bathymetry;
- frequency dependence; and
- source characteristics.

Sound propagation modelling for this assessment was based on an established, peer reviewed sound propagation model which utilises the semi-empirical model developed by Rogers (1981). The model provides a robust balance between complexity and technical rigour over a wide range of frequencies, has been validated by numerous field studies and has been benchmarked against a range of other models.

The propagation loss is calculated using the formula:

$$TL = 15 \log_{10} R + 5 \log_{10} (H\beta) + \frac{\beta R \theta_L^2}{4H} - 7.18 + \alpha_w R$$

Where  $R$  is the range,  $H$  the water depth,  $\beta$  the bottom loss,  $\theta_L$  the limiting angle and  $\alpha_w$  the absorption coefficient of sea water ( $\alpha_w$  is a frequency dependant term which is calculated based on Ainslie and McColm, 1998).

The limiting angle,  $\theta_L$  is the larger of  $\theta_g$  and  $\theta_c$  where  $\theta_g$  is the maximum grazing angle for a skip distance and  $\theta_c$  is the effective plane wave angle corresponding to the lowest propagating mode.

$$\theta_g = \sqrt{\frac{2Hg}{c_w}} \quad \theta_c = \frac{c_w}{2fH}$$

Where  $g$  is the sound speed gradient in water and  $f$  is the frequency and  $c_w$  is the sound speed in water.

The bottom loss  $\beta$  is approximated as:

$$\beta \approx \frac{0.477(\rho_s/\rho_w)(c_w/c_s)K_s}{[1 - (c_w/c_s)^2]^{3/2}}$$

Where  $\rho_s$  is the density of sediment,  $\rho_w$  the density of water,  $c_s$  the sound speed in the sediment and  $K_s$  is the sediment attenuation coefficient.

The propagation model also takes into account the depth dependent cut-off frequency for propagation of sound (i.e. the frequency below which sound does not propagate):

$$f_{cut-off} = \frac{c_w}{4h \sqrt{1 - \frac{c_w^2}{c_s^2}}}$$

The level of detail presented in terms of noise modelling needs to be considered in relation to the level of uncertainty for animal injury and disturbance thresholds. Uncertainty in the sound level predictions will be higher over larger propagation distances (i.e. in relation to disturbance thresholds) and much lower over shorter ones (i.e. in relation to injury thresholds). Nevertheless, it is considered that the uncertainty in

animal injury and disturbance thresholds is likely to be higher than uncertainty in sound predictions. This is further compounded by differences in individual animal response, sensitivity and behaviour. It would therefore be wholly misleading to present any injury or disturbance ranges as a hard and fast line beyond which no effect can occur, and it would be equally misleading to present any noise modelling results in such a way.

It should be borne in mind that noise levels (and associated range of effects) will vary depending on actual conditions at the time (day-to-day and season-to-season) and that the model predicts a typical worst case scenario. Taking into account factors such as animal behaviour and habituation, any injury and disturbance ranges should be viewed as indicative and probabilistic ranges to assist in understanding potential impacts on marine life rather than lines either side of which an impact definitely will or will not occur. (This is a similar approach to that adopted for airborne noise where a typical worst case is taken, though it is known that day-to-day levels may vary to those calculated by 5 to 10 dB depending on wind direction etc.).

As well as calculating the sound pressure levels at various distances from the source, it is also necessary to calculate the SEL for a mammal or fish using the relevant weightings described previously taking into account the amount of sound energy to which it is exposed over the course of a 24-hour period. In order to carry out this calculation, it has been assumed that a mammal will swim away from the noise source at an average speed of  $1.5 \text{ ms}^{-1}$  (or  $0.5 \text{ ms}^{-1}$  for fish). The calculation considers each second of exposure separately resulting in a series of discrete SEL values of decreasing magnitude. As the mammal or fish swims away, the noise will become progressively quieter; the cumulative SEL is worked out by logarithmically adding the SEL to which the mammal is exposed as it travels away from the source. This calculation was used to estimate the approximate minimum start distance for a marine mammal or fish in order for it to be exposed to sufficient sound energy to result in the onset of potential injury. It should be noted that the sound exposure calculations are based on the simplistic assumption that the source is active continuously over the piling period and that the animal will continue to swim away at a fairly constant relative speed. The real world situation is more complex and the noise source will vary in space and time and the animal is likely to move in a more complex manner<sup>4</sup>.

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<sup>4</sup> Swim speeds of marine mammals have been shown to be up to  $5 \text{ ms}^{-1}$  (e.g. cruising minke whale  $3.25 \text{ ms}^{-1}$  (Cooper et al. 2008) and, harbour porpoise up to  $4.3 \text{ ms}^{-1}$  (Otani et al. 2000)). The more conservative swim speed of  $1.5 \text{ ms}^{-1}$  used in this assessment allows some headroom to account for the potential that the marine mammal might not swim directly away from the source, could change direction or does not maintain a fast swim speed over a prolonged period.

## 5 Sound Modelling Results

Injury and disturbance impact ranges for the sources studied in the current study are summarised in Table 5.1 and Table 5.2. The distances presented in the table reflect the start point of the mammal relative to the source when the source first starts up. All ranges are rounded to the nearest 5 m.

**Table 5.1: Summary of potential injury and disturbance zones for rotary drilled piling (N/E – not exceeded)**

Species	Range of effect		
	PTS	TTS	Disturbance
Low-frequency (LF) cetaceans	N/E	N/E	275 m
High-frequency (HF) cetaceans	N/E	N/E	275 m
Very High-frequency (VHF) cetaceans	N/E	N/E	275 m
Phocid Carnivores in Water (PCW)	N/E	N/E	275 m
Other Marine Carnivores in Water (OCW)	N/E	N/E	275 m
	<b>Mortality / potential mortal injury</b>	<b>Recoverable Injury</b>	<b>TTS</b>
Groups 1 and 1 Fish	No threshold	No threshold	No threshold
Groups 3 and 4 Fish	No threshold	N/E	N/E

**Table 5.2: Summary of potential injury and disturbance zones for top drive drilled piling (N/E – not exceeded)**

Low-frequency (LF) cetaceans	N/E	N/E	240 m
High-frequency (HF) cetaceans	N/E	N/E	240 m
Very High-frequency (VHF) cetaceans	N/E	N/E	240 m
Phocid Carnivores in Water (PCW)	N/E	N/E	240 m
Other Marine Carnivores in Water (OCW)	N/E	N/E	240 m
	<b>Mortality / potential mortal injury</b>	<b>Recoverable Injury</b>	<b>TTS</b>
Groups 1 and 1 Fish	No threshold	No threshold	No threshold
Groups 3 and 4 Fish	No threshold	N/E	N/E

The potential ranges presented for injury and disturbance are not a hard and fast 'line' where an impact will occur on one side and not on the other. Potential impact is more probabilistic than that; dose dependency in PTS onset, individual variations and uncertainties regarding behavioural response and swim speed/direction all mean that it is much more complex than drawing a contour around a location. These ranges are designed to provide an understandable way in which a wider audience can appreciate the potential spatial extent of the impact.

## 6 Conclusions

Based on the modelling conducted as part of this assessment, it is concluded that:

- There is little potential for TTS/PTS to be experienced by marine mammals or fish due to the rotary drilled or top drive drilled piling activities. Disturbance to marine mammals could occur within 240 to 275 m of piling activities.

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