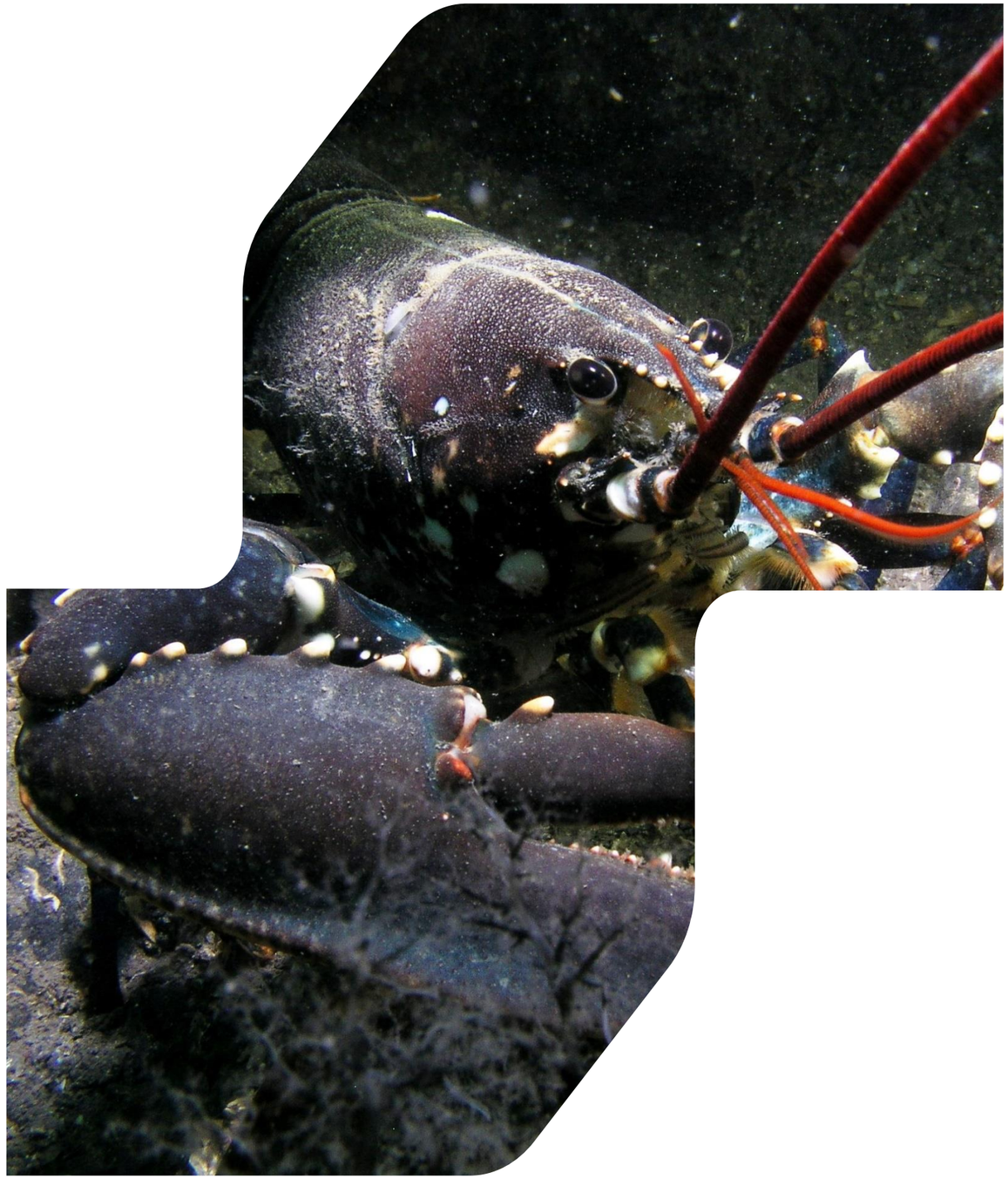
MARINE ENERGY WALES

MARINE ENERGY TEST AREA (META)

Environmental Impact Assessment

Chapter 8:
Fish and Shellfish Ecology



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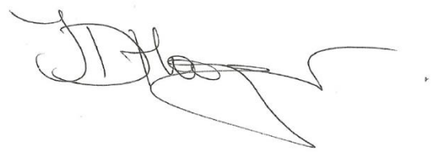
Jessica Hooper  2019-12-05

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Glossary

Term	Definition
Bathymetry	The measurement of water depth in oceans, seas and lakes.
Crustacea	Arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
Demersal	Relating to the seabed and area close to it. Demersal spawning species are those which deposit eggs onto the seabed.
Epibenthic	Organisms living on the surface of the seabed.
Epifauna	Animals living on the surface of the seabed.
Intertidal	An area of a seashore that is covered at high tide and uncovered at low tide.
Mollusc	Invertebrate animal belonging to the phylum mollusca that includes snails, clams, chitons, tooth shells, and cephalopods (e.g. octopus, squid and cuttlefish).
Nursery habitat	Habitats where high numbers of juveniles of a species occur, having a greater level of productivity per unit area than other juvenile habitats.
Pelagic	Any part of the water column (i.e. the sea from surface to bottom sediments) that is not close to the seabed. Pelagic spawning species release their eggs into the upper layers of the sea.
Planktivorous	Feeding on plankton
Plankton	Small and microscopic organisms drifting or floating in the sea or fresh water, consisting chiefly of diatoms, protozoans, small crustaceans, and the eggs and larval stages of larger animals.
Recoverable injury	Relating to underwater noise impacts, recoverable injury includes hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.
Spawning	The release or deposition of eggs and sperm, usually into water, by aquatic animals.
Zooplankton	Plankton consisting of animals (e.g. small crustaceans or immature stages of larger animals)

Acronyms

Acronym	Description
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
MPCP	Marine Pollution Contingency Plan
DDV	Drop Down Video
OSPAR	Oslo-Paris Convention

Units

Unit	Description
dB	Decibel
kW	Kilowatt (power)
km	Kilometre
m	Metre
mg/l	Milligram per litre
mm	Millimetre
MW	Megawatt (power)
m^2	Metres squared
m^3	Metres cubed
NM	Nautical mile
µPa	Micropascal

8. FISH AND SHELLFISH ECOLOGY

8.1 Introduction

8.1.1.1 This chapter of the Environmental Statement presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of the META project on fish and shellfish. Specifically, this chapter considers the potential impact of the offshore component of the META project during its installation, operation and maintenance, and decommissioning phases.

8.1.1.2 The assessment presented is informed by the following technical chapters:

- Chapter 5: Coastal Processes;
- Chapter 7: Benthic Subtidal and Intertidal Ecology; and
- Chapter 11: Commercial Fisheries.

8.2 Purpose of this chapter

8.2.1.1 The primary purpose of the Environmental Statement is to support the marine consent applications for the META project, which are outlined in chapter 1: Introduction, and policy and legislation in chapter 3: Needs and Alternatives.

8.2.1.2 It is intended that the Environmental Statement will provide statutory and non-statutory consultees with sufficient information to determine the potential significant impacts of the META project on the receiving environment and will inform the issue of appropriate consent and/or licences by the regulatory authorities. It will also inform any consent conditions.

8.2.1.3 In particular, this Environmental Statement chapter:

- Presents the existing environmental baseline established from desk studies, historical surveys of Milford Haven undertaken by RPS and consultation;
- Presents the potential environmental effects on fish and shellfish arising from the META project, based on the information gathered and the analysis and assessments undertaken;
- Identify any assumptions and limitations encountered in compiling the environmental information;
- Highlight any mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process; and
- Highlight any monitoring deemed appropriate in order to validate the findings of this assessment.

8.3 Study area

8.3.1.1 Fish and shellfish are spatially and temporally variable, therefore the META Project fish and shellfish ecology assessment has identified an appropriate study area that encompasses Warrior Way (site 6), Dale Roads (Site 7) and East Pickard Bay (site 8) (Figure 8.1). The fish and shellfish study area also includes the upper reaches of the Milford Haven waterway (subsequently referred to as 'the Waterway', the western and eastern Cleddau rivers, Daugleddau, Milford Haven waters, and all associated tributaries (extending from the mouth of Milford Haven, between St Govan's Head to Skomer Island, out to 12 NM (Figure 8.1).

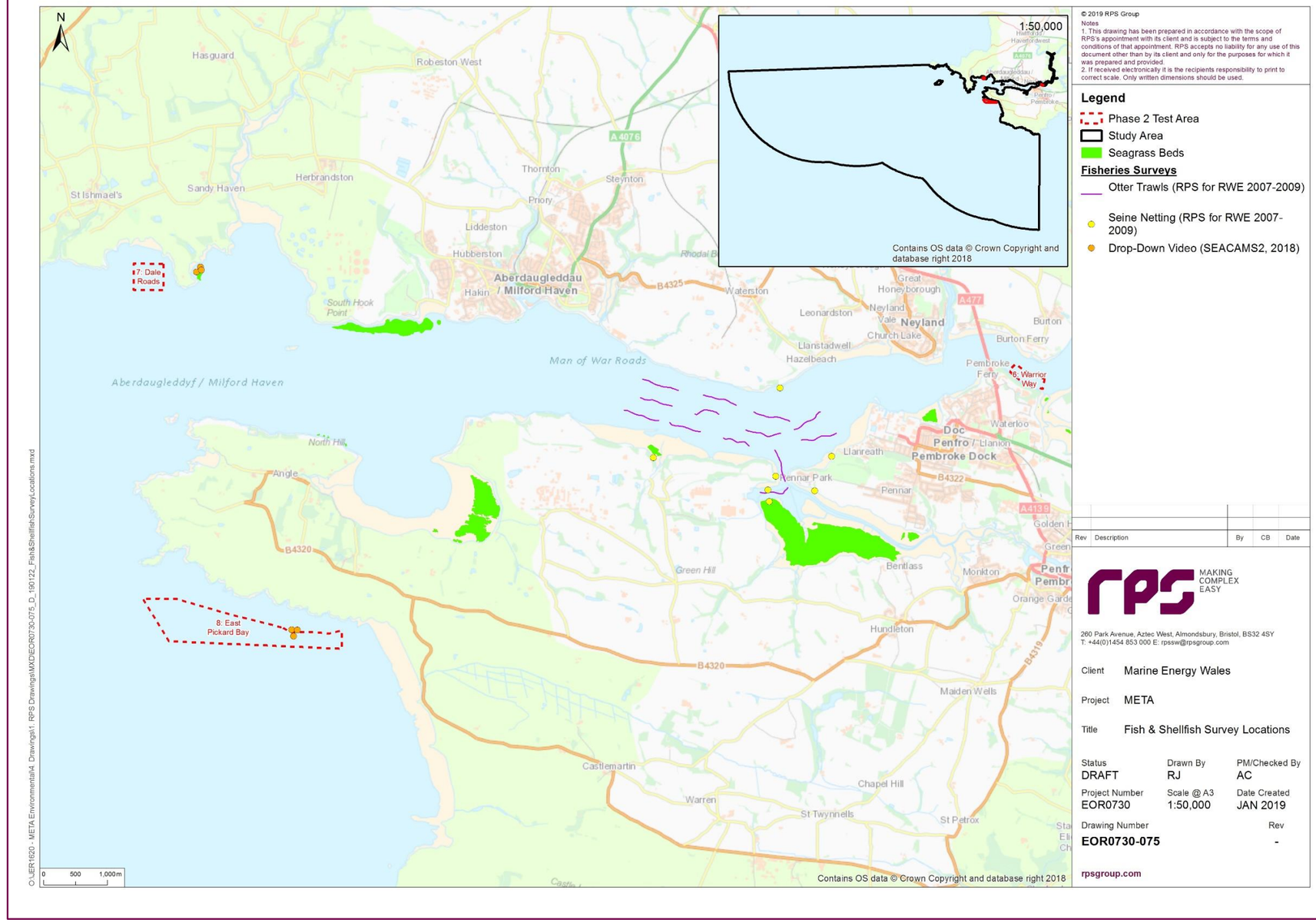

Figure 8.1: The fish and shellfish study area, including historic surveys across the Waterway and adjacent waters.

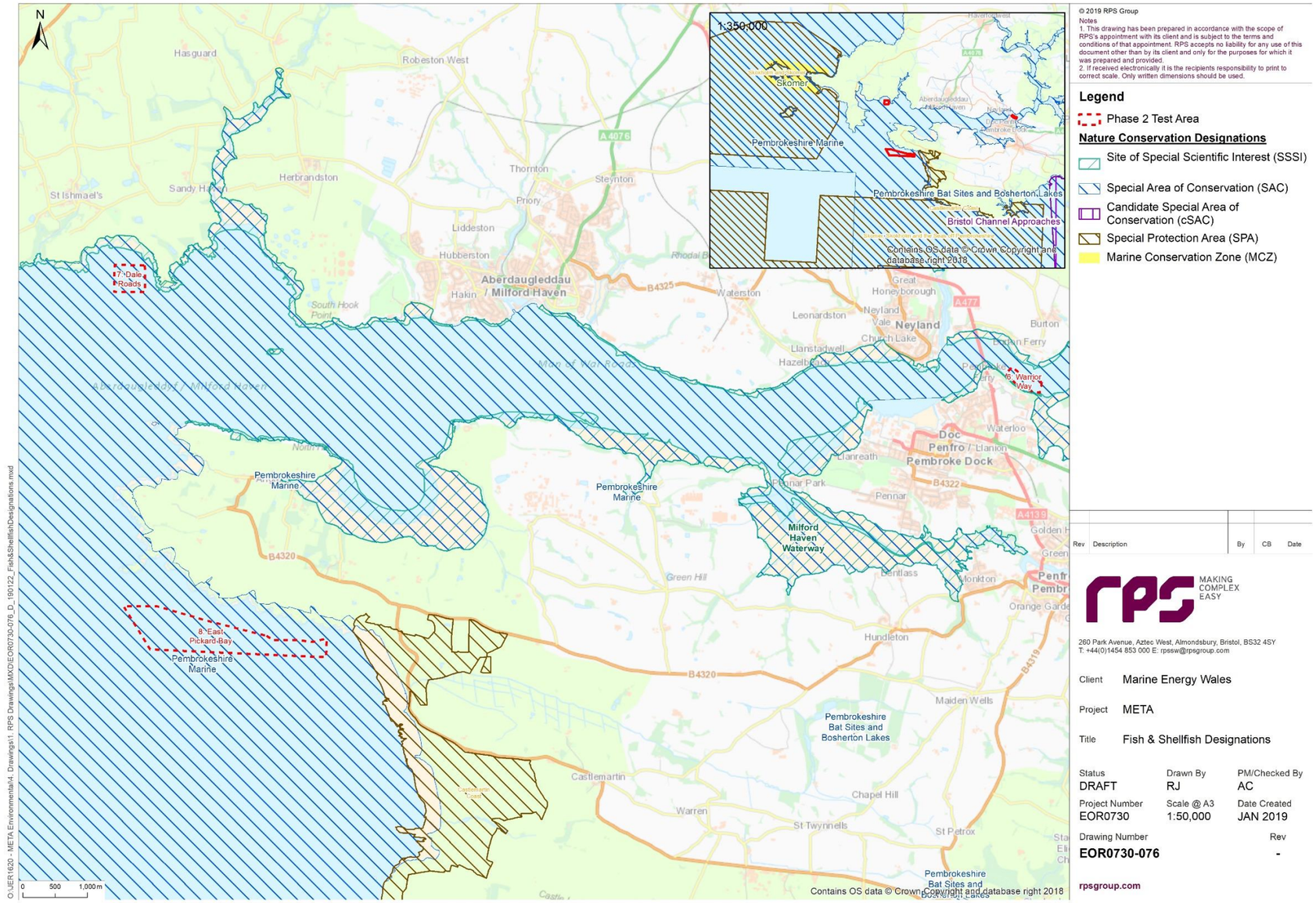

Figure 8.2: The META project in relation to designated sites with fish and shellfish notified interest features.

8.4 Policy context

8.4.1 National Policy Statements

8.4.1.1 While it is recognised that the META project does not constitute a Nationally Significant Infrastructure project (NSIP), the National Policy Statements (NPS) available to support NSIPs are considered to provide useful context to the production of fish and shellfish environmental assessments. In addition, the UK Marine Policy Statement and the draft Welsh National Marine Plan (dWNMP) (Welsh Government, 2018) have been considered in chapter 3: Needs and Alternatives and not reiterated here.

8.4.1.2 Planning policy on renewable energy infrastructure, specifically in relation to fish and shellfish, is contained in the overarching National Policy Statement (NPS) for Energy (EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (EN-3; DECC, 2011b).

8.4.1.3 NPS EN-1 and NPS EN-3 include guidance on what matters should be considered in a fish and shellfish environmental impact assessment. These are summarised in Table 8.1 and Table 8.2, respectively.

8.4.1.4 NPS EN-3 also highlights several factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 8.3.

Table 8.1: Summary of NPS EN-1 policy relevant to fish and shellfish.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
Where the development is subject to EIA the applicant should ensure that the Environmental Statement clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. (paragraph 5.3.3 in NPS EN-1).	Effects on Fish and Shellfish, including species of conservation importance, including those listed as features of designated sites, are fully considered in sections 8.11.2 (installation phase),8.11.3 (operation and maintenance phase) and 8.11.4 (decommissioning phase). Baseline information on these receptors is presented in section 8.7, with an evaluation of these receptors in the context of their conservation importance considered in section 8.7.7.
The most important sites for biodiversity are those identified through international conventions and European Directives. The Habitats Regulations provide statutory protection for these sites (paragraph 5.3.9 in NPS EN-1).	Effects of fish and shellfish features have been assessed within the report to inform the Habitats Regulation Assessment for Natura 2000 sites.
Many Sites of Special Scientific Interest (SSSI) are also designated as sites of international importance; those that are not, should be given a high degree of protection (paragraph 5.3.10 of NPS EN-1). Where a proposed development within or outside a SSSI is likely to have an adverse effect on a SSSI (either individually or together with other developments), development consent should not normally be granted. Where an adverse effect, after mitigation, on the site's notified special interest features is likely, an exception should only be made where the benefits (including need) of the development at this site clearly outweigh both the impacts on site features and on the broader network of SSSIs (paragraph 5.3.11 of NPS EN-1).	The META project lies partly within the Waterway SSSI. This SSSI underpins the Pembroke Marine SAC, therefore consideration of the potential impacts on the SSSI have been considered within the Habitats Regulation Assessment presented as part of this application. The META project lies out with any other SSSIs (see paragraph 8.7.6). However, where the SAC designation does not list a qualifying interest feature that is present on the SSSI citation, the individual SSSI will be taken forward for further assessment for that particular feature or species.
Marine Conservation Zones (MCZs) introduced under the Marine and Coastal Access Act (MCAA) 2009 are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitat or features of geological or geomorphological interest (paragraph 5.3.12 in NPS EN-1).	Skomer MCZ is the only MCZ in Wales (Figure 8.2) and can be found within the vicinity of the META project fish and shellfish study area (see section 8.7.6)
Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales and thereby requiring conservation action (paragraph 5.3.17 in NPS EN-1).	All species receptors, including those of principal importance for the conservation of biodiversity in Wales are summarised in section 8.7, with evaluation of these receptors in the context of their conservation importance considered in section 8.7.7.
The applicant should include appropriate mitigation measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During installation, they will seek to ensure that activities will be confined to the minimum areas required for the works; and • During installation and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements.	Mitigation measures proposed for the META project are presented in section 8.10.

Table 8.2: Summary of NPS EN-3 policy relevant to fish and shellfish.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
Applicants should assess the effects on the offshore ecology and biodiversity for all stages of the lifespan of the proposed project (paragraph 2.6.64 of NPS EN-3).	Installation, operation and maintenance, and decommissioning phases of the META project have been assessed (see section 8.11).
Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate (paragraph 2.6.65 of NPS EN-3).	Consultation with relevant statutory and non-statutory stakeholders has been carried out from the early stages of META (see section 8.5).
Applicants should assess the potential for the scheme to have both positive and negative effects on marine ecology and biodiversity (paragraph 2.6.67 of NPS EN-3).	Both the potential positive and negative effects of the META project have been assessed (see section 8.11).
Fish and shellfish ecology	
Impacts arising from installation and decommissioning at the seabed with consequential effects on fish communities, migration routes, spawning activities and nursery areas for particular species (paragraph 2.6.73 of NPS EN-3).	The META project assessment has considered all phases of the META project development on fish and shellfish species with key life stages in the vicinity of the development (see section 8.11).
In addition, there are potential noise impacts, which could affect fish during installation and decommissioning and to a lesser extent during operation and maintenance (paragraph 2.6.73 of NPS EN-3).	The META assessment has considered noise effects on fish and shellfish species arising from installation and decommissioning (piling and vessel noise; see Table 8.13)

Summary of relevant policy framework	How and where considered in the Environmental Statement
The applicant should identify fish species that are the most likely receptors of impacts with respect to feeding areas; spawning grounds; nursery grounds; and migration routes (paragraph 2.6.74 of NPS EN-3).	Focus has been given to potential impacts on fish (and shellfish) species at key life stages, such as during spawning or on known nursery habitats (see section 8.7 *et seq.*).

Table 8.3: Summary of NPS EN-3 policy on decision making with regards to fish and shellfish and consideration of the META project assessment.

Summary of relevant policy framework	How and where considered in the Environmental Statement
Biodiversity	
The local planning authority should consider the effects of a proposal on marine ecology and biodiversity taking into account all relevant information made available to it (paragraph 2.6.68 of NPS EN-3).	This fish and shellfish impact assessment (section 8.11) considers the effects of the META project on fish and shellfish ecology.
The designation of an area as a European site does not necessarily restrict the installation or operation and maintenance of a project in or near that area (paragraph 2.6.69 of NPS EN-3).	European sites have been considered during the assessment (see section 8.7.6) and in the RIAA.

8.5 Consultation

8.5.1.1 A summary of the key issues raised during consultation specific to fish and shellfish is outlined in Table 8.4, together with how these issues have been considered in the production of this Environmental Statement chapter.

8.5.1.2 Table 8.4 also indicates either how these issues have been addressed within this Environmental Statement or how the Applicant has regarded them.

Table 8.4: Summary of key consultation issues raised during consultation activities undertaken for the META project relevant to fish and shellfish.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
20 November 2018	Welsh Federation of Sea Anglers - meeting	No issues raised	No response made.
09 November 2018	Wales Marine Fisheries Advisory group and Wales Fishing Association – fisheries engagement	Loss of fishing opportunity is the greatest concern	There is no restriction to fish or shellfish from entering the consented zone, therefore, no decrease in fish and shellfish abundance (see section 8.10).
28 March 2019	NRW Scoping Opinion (ABPmer advice to NRW)	According to the fish and shellfish ecology section of the Scoping Report, potential effects of marine noise on fish and shellfish are proposed to be scoped out of the EIA on the basis that the installation, operation and maintenance and decommissioning of marine renewable devices will result in noise levels lower than ambient noise levels experienced within study area. This does not correspond with the underwater noise section of the Scoping Report which presents a proposed approach to assessing the effects of the installation and operation and maintenance of devices on fish and benthic ecology.	Marine noise is generated by the META project is considered to be equal or less than the baseline noise present within the Waterway. See Table 8.13: Impacts scoped out where justification is provided for scoping this impact out.
		The further assessment work that is proposed to be undertaken as part of the EIA will comprise a desk-based review of publicly available underwater noise levels from the installation, operation and maintenance and decommissioning activities, including drilled piling. The potential range of injury and disturbance in fish and marine mammals for these different activities will then be predicted. The most recent published exposure criteria or acoustic thresholds for effects on fish and marine mammals will be used to inform the assessment. The potential impacts on benthic ecology will also be considered, with a particular focus on SAC qualifying habitat features.	Potential marine noise generated by the META project is considered unlikely for injury to occur to any marine mammal or fish species as a result of the META project. See Table 8.13: Impacts scoped out where justification is provided for scoping this impact out
		The underwater noise assessment should also include a desk-based review of the latest available scientific evidence of the observed responses of marine fauna (namely fish, marine mammals and benthic invertebrates) to different types of underwater sounds for context. Although scientific research on the potential effects of underwater noise on invertebrates is relatively underdeveloped, there is increasing evidence to suggest that invertebrates are sensitive to noise, in particular particle motion.	Potential marine noise generated by the META project is considered likely to be equal or less than the baseline noise present within the Waterway. See Table 8.13: Impacts scoped out where justification is provided for scoping this impact out
28 March 2019	NRW Scoping Opinion (ABPmer advice to NRW)	Under operation and maintenance phase impacts we would also expect change in the hydrodynamic regime as the result of tidal device installation at the Warrior Way test site to be included in the coastal processes assessment.	Changes in hydrodynamic regime are assessed in chapter 5: Coastal Processes. Section 0 *et seq.* assess any changes in fish and shellfish as a result of changes in hydrodynamic regime.
28 March 2019	NRW/MMO – Scoping Opinion	Some fish species have not been included in the scoping report which are found in the Haven. However, the list of fish proposed for assessment in the EIA should be sufficient to provide a variety of fish species for which impacts can be evaluated against; these can act as proxies to other similar species. Should further literature reviews identify particular areas of importance for spawning or feeding of other species within the site areas that are not on the list, these fish species must be included within the assessment.	A thorough review of data sources has highlighted fish and shellfish species present within the Milford Haven Waterway, these are outlined in the baseline assessment, section 8.7.
		The project envelope described provides no detail on the levels of noise that may be omitted from device types during operation and maintenance, particularly for tidal devices at Warrior Way. For example, is there potential for disturbance and avoidance impacts and barrier effect impacts. We suggest that these be explored further in the EIA.	Chapter 6: Underwater Noise describes the predicted levels of noise that may occur as a result of device operation, including tidal devices. The data presented in chapter 6: Underwater Noise has been used to provide Table 8.13 justification for scoping out any potential impacts on fish and shellfish due to underwater noise generated by marine devices and is detailed in Table 8.13 .
		It is stated that operational testing could be "throughout the year (will not be seasonally restricted) and will not be restricted to daylight hours". Some species could be vulnerable to turbine movements, and this must be considered in the EIA/ Environmental Statement. For example, herring migrating to spawning grounds further up the Haven in early spring could be vulnerable to turbine passage.	Impacts on fish, including herring migration and spawning have been assessed in the operation and maintenance assessment, section 8.11.3,.
		The section on shellfish is not entirely accurate. There are no current permits for carpet clams, razor or native oyster fisheries. Oysters were historically widespread in the Haven but are now depleted and there is no current oyster dredge fishery in the Haven. There are however still important oyster bed habitats within the Haven which have high sensitivity to certain benthic impacts such as disturbance and habitat loss.	Baseline section 8.7 has been updated to reflect NRW comments.
		The same impacts identified within the benthic section (Table 6-4) must be assessed in the EIA/Environmental Statement for shellfish.	Where appropriate, similar impacts have been assessed for benthic interests as for fish and shellfish. These include for installation; 'Temporary changes to fish and shellfish habitat' (section 8.11.2.1), 'Temporary increases in

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
			suspended sediments' (section 0) and 'Accidental Pollution' (section 8.11.2.58). For operation and maintenance impacts; 'Medium term habitat loss' (section 8.11.3.23) has been included.
		Impacts from the operation of the turbines should also be included for fish species as they can lead to disturbance, injury and mortality.	Potential impacts of operational scaled tidal turbines has been assessed in chapter 8: Fish and Shellfish through impacts 'collision risk with tidal turbines' (section 8.11.3) and 'physical barrier to movement due to presence of tidal turbines (8.11.3).
		Injury and mortality impacts from wave devices must be considered in the EIA/Environmental Statement. It is acknowledged that the majority of wave devices present little concern for impacts on fish, however, some devices have the potential for fish ingress within the device. Other unforeseen impacts may also occur. A review of existing wave devices would help to identify potential other impacts which may be relevant to the EIA.	Appendix 2.1 provides an overview of wave and tidal devices, some of which may be deployed at the META project. It will be a condition of testing at META project sites Dale Roads (site 7) and East Pickard Bay (site 8), that potential for fish ingress will be minimised through device design and engineering stage. Impacts scoped out and justification for scoping this impact out are provided in Table 8.13.
		Table 6-6 includes some of the species found within the Waterway and identifies those of primary conservation importance. Seahorses must also be considered as they are Schedule 5 species under the Wildlife and Countryside Act, with *Hippocampus guttulatus* recorded in the Milford Haven.	Seahorses have been considered in 8.7.3.2 however there is no preferred seahorse habitat present within any of the META sites and a lack of data suggesting their presence within the Waterway.
		We disagree with scoping out all operation and maintenance effects on fish (table 6-8). There is not enough information at this stage on types of device or worst-case scenario proposed to scope out impacts 2,3,4 and 5. Impacts from the operation of the turbines must be included for fish species and this must include assessment of disturbance, injury and mortality.	Operation and maintenance impacts assessed for fish include 'Colonisation hard structure' (section 8.11.3.2), 'Medium term habitat loss' (section 8.11.3.23) and 'Accidental pollution' (installation – section 8.11.2.58.
		Basking sharks have been included in the marine mammals chapter of the scoping report rather than fish ecology. Basking sharks should be considered in the fish ecology chapter of the EIA/Environmental Statement.	Assessment of potential impacts on basking shark are included within chapter 9: Marine Mammals, Basking shark and Otters.

8.6 Methodology to inform the baseline

8.6.1.1 The META project is located with the Waterway and its adjacent waters, for which extensive data and knowledge regarding fish and shellfish ecology is already available. This extensive data/knowledge has been acquired through:

- Publicly available journals;
- University studies;
- Commissioned reports by local interest groups;
- East Pickard Bay (site 8) baited drop down video surveys; and
- Historical characterisation surveys undertaken by RPS for projects within the Waterway.

8.6.1.2 Due to the availability of suitable data throughout the Waterway, new data or modelling studies have not been required to characterise the fish and shellfish baseline for the META project EIA (see chapter 4: Environmental Assessment Methodology). UK nature conservation designations occurring within the fish and shellfish study area have also been used to inform the fish and shellfish baseline (Figure 8.2).

8.6.2 Desktop study

8.6.2.1 Information on fish and shellfish within the fish and shellfish study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 8.5 below. Where reports and data date back to the 1990s, up-to-date data and information have been used to ensure these sources are still valid.

Table 8.5: Summary of key desktop reports.

Title	Source	Year	Author
International Bottom Trawl Surveys	ICES; http://datras.ices.dk/home/descriptions.aspx	2017	ICES
International Herring Larvae Survey (IHLS)	ICES; http://www.ices.dk/marine-data/data-portals/Pages/Eggs-and-larvae.aspx	2015	ICES
Crab and lobster stock assessments	Cefas	2017	Cefas
Spawning and nursery grounds of selected fish species in UK waters	Cefas Scientific Series Technical Report	2012	Ellis *et al*.
Fisheries Sensitivity Maps in British Waters	Cefas Scientific Series Technical Report	1998	Coull *et al.*
Wales Marine Planning Portal	Welsh Government	Compiles a series of relevant data sources	n/a
National Biodiversity Network (NBN) Gateway	NBN Atlas	Compiles a series of relevant data sources	n/a

Identification of designated sites

8.6.2.2 All designated sites within the fish and shellfish study area that could be affected by the installation, operation and maintenance, and decommissioning of the META project, were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the fish and shellfish study area were identified using a number of sources. These included international, national and local designations including SACs, SPAs, NNRs, SSSIs and LNRs identified by examining the JNCC's website, the European Site European Nature Information System (EUNIS) database, the Department for Environment, Food and Rural Affairs (Defra), MAGIC interactive map applications (http://magic.defra.gov.uk/), and the Wales Marine Planning Portal interactive map application (http://lle.gov.wales/apps/marineportal).
- Step 2: Information was compiled on the relevant qualifying fish and shellfish interest features for each of these sites:
  - The known occurrence of species within the META project was based on the relevant desktop information on the fish communities of the fish and shellfish study area.
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the META project;
  - Sites and associated features were located within the potential Zone of Impact (ZoI) for impacts associated with the META project (e.g. habitat loss/disturbance, increase in suspended sediments and deposition);
  - Notified interest species features of a designated site were either recorded as present during historic surveys within the META project area, or identified during the desktop study as having the potential to occur within the META project area;
  - Where national and locally designated sites (i.e. SSSIs, rMCZs, NNRs and LNRs) fall within the boundaries of an internationally designated site (e.g. SAC), only the international site has been considered, as potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken). In some cases, however, where a national site forms a component of an international site, but the latter designation does not list a qualifying interest feature that is present on the SSSI citation, the individual SSSI will be taken forward for further assessment for that particular feature or the species;
  - Where a national site falls outside of an international site, but within the fish and shellfish study area, the national site will be taken forward for further assessment for a particular feature; and
  - Skomer MCZ is the only MCZ designated in Wales and as such is the only one considered for assessment.

8.6.3 Historical RPS surveys

8.6.3.1 A summary of surveys used to inform the fish and shellfish EIA is outlined in Table 8.6 below.

Table 8.6: Summary of survey data used to inform fish and shellfish baseline characterisation.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Bombora camera drop down video (DDV) survey	Six DDV surveys were undertaken within East Pickard Bay (site 8) by Bombora Wave Energy (Bombora) and Swansea University in June 2018	DDV surveys to identify fish species present in East Pickard Bay (site 8) and Milford Haven. DDV surveys were left in position for 1 hour with bait (mackerel) to attract fish species at varying depths (6 – 18 m). Both benthic and demersal species were attracted.	SEACAMS Ltd.	2018	Appendix 8.1
Otter Trawls	Thirteen otter trawl surveys were carried out in the vicinity of the Pembroke Power station.	Otter trawl surveys were used to determine the fish community present within the Waterway.	RPS	2007-2009	RPS, 2007
Seine Netting	Severn seine nets were deployed in the vicinity of the Pembroke Power station.	Seine nets were deployed to determine the fish community present within the Waterway.	RPS	2007-2009	RPS, 2007

8.7 Baseline environment

8.7.1.1 This section characterises the existing environment within the fish and shellfish study area as illustrated in Figure 8.1 and outlined in section 8.2.1.1.

8.7.2 Regional Fish and Shellfish Assemblage

8.7.2.1 The inshore waters of Pembrokeshire consist of a wide range of demersal, bentho-pelagic and pelagic fish species, such as European plaice *Plueronectes platessa*, herring *Clupea harrengus* and cod *Gadus morhua*. Both mobile and sessile shellfish inhabit both the intertidal and subtidal regions of the area, and elasmobranchs, such as sharks, skates and rays, can be found foraging for prey. The area is home to species of both commercial and conservation importance. For instance, the Waterway has been designated for its migratory fish species and acts as a spawning and nursery ground for a number of species.

8.7.3 Local Fish Assemblages

8.7.3.1 The fish communities characterising the fish and shellfish study area were found to show significant variation in assemblages due to the salinity gradient from the mouth of the Waterway (full salinity) through to the Cleddau rivers (fresh water) (as described in section 8.3.1.1). The Waterway provides a diverse habitat of hard and soft substrates to support a wide variety of fish species, which is further enhanced by the presence of artificial/biological structures such as jetty piles, docks and localised beds of *Zostera* spp. and other macrophytes. Species found are described to be typical of species expected for an estuary of this type.

8.7.3.2 Within the fish and shellfish study area, Warrior Way (site 6) and Dale Roads (site 7) are situated within the Waterway and within a semi-diurnal tidal setting with a meso-tidal range (PCNPA, 2013a & b). East Pickard Bay (site 8) is located to the south of the Waterway, where the tidal range can be found to remain consistent with minimal seasonal variation (PCNPA, 2013c). The geology of the area can be found to be predominately hard, red calcareous marls with sporadic red and green sandstones and very fine to coarse-grained sediments. The resulting geology and coastal processes have resulted in a range of biogenic and geogenic reef structures providing suitable habitat for migratory, demersal, benthic and pelagic fish species, as well as allowing shellfish to settle. Further information on coastal processes and the benthos can be found in chapter 5: Coastal Processes and chapter 7: Benthic Subtidal and Intertidal Ecology, respectively.

8.7.3.3 DDV surveys were undertaken at the East Pickard Bay (site 8), near the mouth of the Waterway, and within the Waterway, near Dale Roads (site 7), in June 2018 recorded assemblages of primarily dermersal fish species of *Triglidae* (includes sea robins and gurnards, bottom-feeding fish), common dab *Limanda limanda,* European plaice and Pleuronectidaem (includes flounders). The elasmobranch *Scyliorhinidae* (family of catsharks) and small-spotted catshark *Scyliohinus canicular* were also recorded.

8.7.3.4 RPS also undertook seasonal otter trawl and seine netting surveys for the proposed Pembroke Power station, in 2006 and 2007. These were carried out approximately mid-way in the Waterway (RPS, 2007; Figure 8.1). Assemblages recorded were gobies *Pomatoschistus* spp, sand smelt *Atherina presbyter* and sea bass *Dicentrarchus labrax*, clupeids including sprat *Sprattus spattus* and herring, pollack *Pollachius pollachius,* plaice, three species of mullet; thick lipped *Chelon labrosus*, thin lipped *Liza ramada* and golden grey *Liza aurata* and Atlantic salmon *Salmo salar*. Of these species the most abundant fish species sampled were gobies. with 400 individuals recorded in one trawl, associated with seagrass (*Zostera* spp.) and muddy seabed found within the trawl area (Figure 8.1). Elasmobranch species recorded were thornback ray *Raja clavate* and small-spotted catshark.

8.7.3.5 In addition to the surveys described above, other elasmobranchs species identified include other species of ray and tope *Galeorhinus galeus*, some of which have commercial importance. Low intensity nursery areas for these species occur in the area (see section 8.7.3.22 *et seq.*, for information on spawning and nursery habitats). Tope is listed as vulnerable on the IUCN Red List of Threatened Species.

8.7.3.6 The fish and shellfish study area provide a suitable spawning habitat for cod, sandeel *Ammodytes americanus*, plaice, sole *Solea vulgaris*, herring and sprat (Ellis *et al.,* 2012). The sheltered estuarine conditions also provide a safe environment for juvenile fish and other smaller species of fish, such as seahorses. The fish and shellfish study area can be considered as an important nursery area for sandeel, plaice, sole, whiting *Merlangius merlangus*, herring, mackerel, spotted ray *Raja montagui*, thornback ray and tope (Ellis *et al*., 2012) (see section 8.7.3.22 *et seq*, for information on spawning and nursery habitats).

Migratory Fish Species

8.7.3.7 A number of migratory fish species have been designated as primary features of both the Milford Haven/ Sir Benfro Forol and the Cleddau River/Afnydd Cleddau SACs (see section 8.7.6). They have the potential to occur in the fish and shellfish study area, migrating to and from the Cleddau rivers which these species use either for spawning habitat or as a nursery area for growth and development into the adult stage (JNCC, 2017). Migratory fish species are of conservation importance as Annex II species protected under European legislation or as Welsh BAP priority species (see Table 8.10).

8.7.3.8 Four diadromous migratory fish are qualifying interest features of the Pembrokeshire Marine 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 SAC (Table 8.8). Atlantic salmon, 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 and have been found transiting the Waterway, however they are not features of either SAC.

Sea Lamprey

8.7.3.9 The sea lamprey is distributed throughout the UK and can be found from the most southern regions of England up to the most northern parts of its ecological range in Scotland. Spawning occurs in lower reaches of the Cleddau Rivers in freshwater gravel beds. Upon hatching, juvenile lamprey will often burry themselves in gravel, silt or sand, to prevent predation. After five years in freshwater the lamprey progressively makes their way to the open sea to mature.

8.7.3.10 Barriers, such as weirs and dams, and pollution, can pose an obstacle to lamprey, leading to a decline in their population.

8.7.3.11 Records of sea lamprey occurring within the Waterway are limited, with the NBNAtlas indicating no confirmed lamprey sightings, but there are known populations within the Cleddau Rivers. Based on the precautionary principle it can be assumed that sea lampreys are present in the Waterway, however numbers are expected to be low compared to other rivers found within the Bristol Channel area.

River Lamprey

8.7.3.12 The river lamprey can be found throughout the UK and western reaches of Europe and shares a similar ecology to the sea lamprey but is morphologically smaller (Maitland, 2003).

8.7.3.13 The river lamprey has been identified as an Annex II species that is a primary reason for the SAC selection of the Cleddau Rivers SAC. A known population occurs within the Cleaddau rivers and therefore can be expected to pass through the Waterway.

Allis and Twaite Shad

8.7.3.14 Both allis and twaite shad are in decline in many parts of Europe due to overfishing, pollution and migratory route obstructions. Measuring 30-50 cm, allis shad are usually larger than twaite shad which rarely exceed 40 cm.

8.7.3.15 Relatively little information is available on the habitat requirements of allis shad in freshwater. It grows in coastal waters and estuaries but migrates into rivers to spawn, swimming up to 800 km upstream in continental Europe. However, allis shad do not readily traverse obstacles to migration such as dams or weirs, and this has been a major cause of their decline. Adults spawn at night; the eggs are released into the current where they settle among gaps in gravelly substrates. Spawning sites tend to be used year after year, and relatively shallow gravelly areas adjacent to deep pools are thought to represent optimal spawning habitat. Almost all adults die after spawning.

8.7.3.16 Twaite shad returns from the sea to spawn in spring, usually between April and June. The habitat requirements of twaite shad are not fully understood. Twaite shad are known to spawn at night in shallow areas near deeper pools. The eggs are released into the water column, sinking into the interstices between coarse gravel/cobble substrates. The majority of adults die after spawning, though UK populations appear to have an unusually high proportion of repeat spawners – up to 25%. After hatching the fry develop and slowly drift downstream. Recruitment seems to be highest in warm years, and high flows between May and August may result in fry being washed prematurely out to sea.

Salmonids

8.7.3.17 Salmonids have a relatively primitive appearance among the teleost fish. They are slender fish, with rounded scales and forked tails. Their mouths contain a single row of sharp teeth. All salmonids spawn in fresh water, but in many cases the fish spend most of their lives at sea, returning to the rivers only to reproduce. Species include Atlantic salmon and sea trout.

8.7.3.18 The juvenile life stage of the Atlantic salmon typically lasts between one to four years before migrating to the sea. Following migration to the sea, salmon are known as post-smolts until the spring of the following year and after one winter a grilse. The adult Atlantic salmon spends the majority of its life at sea growing rapidly, only returning to fresh water environments to spawn from November to December but may extend from October to late February (SNH, 2017). Due to a highly acute sense of smell, the Atlantic salmon is able to remember the river in which it was born and on maturity is able to migrate back to the home river to spawn (Dipper, 2001). The length of time an Atlantic salmon spends in the sea varies from one to five years (Marine Scotland, 2011). Atlantic salmon are widely distributed throughout Wales and are recognised as Annex II (EU Habitats Directive), British Action Plan (BAP) species, a priority marine feature (juvenile) and OSPAR Designations. They are currently both nationally and internationally Important species.

8.7.3.19 The sea trout has a similar ecology to the Atlantic salmon but are smaller in size, have a much larger distribution, and remain within nearshore waters rather that undergoing extensive migration offshore (DECC, 2009). Trout spawn in winter from October to January, with the eggs deposited in redds[1] cut by the female in the river gravel. The sea trout has a large distribution throughout Wales and is recognised as a BAP species.

European Eel

8.7.3.20 The European eel has a complex life history, entering two metamorphization stages. Spawning occurs in the Sargasso Sea (mid Atlantic Ocean), after which larval eels cross the Atlantic Ocean. Once eels have reached the continental shelf, they will have metamorphized into 'glass eels', whereby some remain in the sea and others ascend rivers and move between marine, estuarine and freshwater environments. During this time, the European eel will develop pigmentation and are referred to as 'yellow eels'. The yellow eel state can last from 30-60 years before they enter a final metamorphization into 'silver eels' and return to the Sargasso Sea for spawning.

8.7.3.21 European eels are widely distributed throughout Wales and are recognised as a BAP species, priority marine feature, OSPAR Designations, IUCN Red List (critically endangered), and has a European Union Management Plan. They are currently both nationally and internationally Important species.

Spawning and nursery habitats

8.7.3.22 Juvenile fish assessments indicate that most parts of the Waterway support juvenile flatfish, particularly dab and plaice, but also brill *Scophthalmus rhombus* and turbot, *Scophthalmus maximus* with an above average abundance of dab and plaice when compared to figures for the whole of England and Wales (Riley *et al.,* 1986). Survivors of the first-year fish remain in the Waterway for at least a second year with the majority leaving on reaching sexual maturity. The Waterway is also recognised as a minor nursery area for flatfish (Riley *et al.,* 1986).

8.7.3.23 The long snouted seahorse *Hippocampus guttulatus* has been identified outside of the study area and are commonly associated with seagrass beds and areas of rocky reef (Neish, 2007), however there are no records of the species on NBN Atlas within the Waterway and are not included further within the assessment.

8.7.3.24 Herring have been known to spawn at three gravel sites in the Daugleddau (Crothers, 1966; Clarke and King, 1985; Hobbs and Morgan, 1992) although positions vary from year to year according to gravel availability (Figure 8.3). Over the past couple of decades, herring annual reported catches have decreased from circa 100 tonnes in the 1980s to less than 0.1 tonnes in 2018 as a result of market conditions (ICES, 2017; see chapter 11: Commercial Fisheries). An interim report on the Milford Haven herring population by Clarke (pers. comm.)) suggests that spawning is greatly reduced compared to previous years (1980s), that herring growth rates were found to be slower (this was reflected across the wider Celtic Sea Herring population possibly due to environmental pressures and not specific to the Milford Haven) and mean length and weight were found to be considerably reduced potentially affecting fecundity of the species. The spawning area identified adjacent to Warrior Way (site 6) was found to be almost non-existent with no direct evidence of spawning activity. However, this study represents a 'snapshot' in time. Recent surveys (Dr David Clarke pers comm, 2019) has revealed that spawning is still occurring within these known sites as of March 2019.

8.7.3.25 The Pembroke River and the tidal waters of the Daugleddau upstream of the Cleddau Bridge have been identified as bass nursery areas, as has an area in Pembroke Bay around the old power station outfall (Pawson *et al.,* 2002). In these areas, fishing is prohibited between 1 May and 31 October.

8.7.3.26 The spawning and nursery habitats present in the fish and shellfish study area are summarised in Table 8.7 for all species for which data exist. Nursery and spawning habitats were categorised by Ellis *et al*. (2012) as either high or low intensity dependant on the level of spawning activity or abundance of juveniles recorded within these habitats. Species with high intensity habitats within or near the fish and shellfish study area or have overlap with a META site have been given individual species accounts (Figure 8.3 & Figure 8.4).

[1] 'Nests' of spawning fish.

Cod

8.7.3.27 Cod spawning occurs between January to April with peak spawning during February and March, releasing approximately three to six million buoyant eggs that hatch after 12 days. Upon hatching, larval cod enter the plankton and can be carried for up to two months before settling on the seabed where they'll spend the majority of their life feeding on copepods and progressing on to herring, capelin and haddock (Dipper, 2001).

8.7.3.28 Cod is one of the UKs most important commercial species, however, landings data by ICES rectangle 32E4 and 32E5, encompassing the fish and shellfish study area, suggests relatively little fishing activity with on average landed weight of 2.1 tonnes from 2009 -2017 (see Chapter 13: Commercial Fisheries).

Sandeel

8.7.3.29 Sandeel spawning occurs from November to March, where up to 4,000-20,000 eggs are laid in sand and hatch after a few weeks. Sandeels are predominately a bentho-pelagic species that feed predominately on large diatoms, worms and small crustaceans (Dipper, 2001). Sexual maturity is reached at the age of two. The eggs are laid in clumps within sandy substrate until they hatch, after which they enter the water column. Sandeels will then metamorphose and settle in sandy sediments amongst adults (Van Deurs *et al*., 2009). As a result, there is very little movement between spawning and feeding grounds.

8.7.3.30 Sandeel have been categorised as a BAP species but are not of commercial value in the area.

Plaice

8.7.3.31 Plaice are widely distributed demersal flat fish throughout Britain and found within the intertidal region to depths of 8 m, on sand, gravel and mud (Faber Maunsell, 2007). Plaice spawning occurs between December to March, with each female producing up to half a million eggs, which are then laid within well-defined spawning grounds. Plaice are a demersal species and feed predominately on benthic species, cockles *Cerastoderma edule* and razor shells *Ensis magnus*, worms and crustaceans (Dipper, 2001).

8.7.3.32 Plaice is an important commercial fish and caught generally in trawls and seine nets. Average landings data indicates a landed weight of 1.8 tonnes from 2009 – 2017 (see Chapter 13: Commercial Fisheries).

Sole

8.7.3.33 Sole spawning occurs between March to May, releasing eggs into the environment. Sole is a demersal species feeding primarily on bottom-living small crustaceans and molluscs (Dipper, 2001).

8.7.3.34 They are commercially important with an average landed weight of 5.5 tonnes from 2009 – 2017 within the study area (see Chapter 13: Commercial Fisheries).

Herring

8.7.3.35 Herring are widely distributed throughout the UK and can be found in deep waters. Spawning times are dependent on sub-populations, and herring from Welsh waters have been found to spawn March to April (Ellis *et al*. 2012). Sticky Eggs are deposited on a wide range of substrate types, but preferred substrate type is gravel (Drapeau, 1973; Rogers & Stock, 2001). The eggs adhere to the seabed and can form extensive beds. After hatching, the larvae enter the plankton and drift with the current until reaching inshore nursery grounds. After a year they migrate further offshore to join adults at feeding grounds. Spawning grounds have been identified in close proximity to Warrior Way (site 6).

8.7.3.36 Herring currently have a BAP in place and are under an EU management plan to ensure fish stocks are exploited at a maximum sustainable yield.

Sprat

8.7.3.37 Sprat is a coastal pelagic species, often found in shallow water close to shore, and sometimes tolerant of very low salinities (to 4%) (Whitehead, 1985). Sprat are a schooling species, with strong migrations between winter-feeding and spring and summer spawning grounds. Spawning occurs almost throughout the year, either near to coast or up to 100 km out to sea, mainly in April to August (Atlantic and Baltic) or as early as January in the English Channel. The eggs of sprat are pelagic and float either at the surface or in mid-water at a depth of 25 to 50 m. Spawning takes place in the open sea, although some small populations may spawn close to the coasts. The eggs hatch in three to four days, and the larvae drift inshore. The young of the year live close inshore in shallow water, often in schools with first-year herring. Nursery areas have been identified throughout the Waterway.

Whiting

8.7.3.38 Whiting is a widely distributed demersal species occurring at depths between 30 and 100 m throughout UK waters. Whiting has a prolonged spawning period from February to June throughout its range. The eggs and larvae are pelagic, and the young remain pelagic until they attain a length of about 10 cm when they adopt a demersal habit. The nursery grounds tend to be located inshore and juveniles will remain in these areas for one or two years (Faber Maunsell, 2007).

8.7.3.39 Whiting have been categorised as a BAP species.

Table 8.7: Summary of spawning and nursery habitat within the fish and shellfish study area from data present in Coull *et al.* (1998) and Ellis *et al.* (2012) (High intensity habitats that overlap with the fish and shellfish study area have been highlighted in grey).

Species	Latin / scientific name	Spawning habitats		Nursery habitats	
		Description	Distance to fish and shellfish study area (km)	Description	Distance to fish and shellfish study area (km)
Tope	*Galeorhinus galeus*	Location and temporal stability of specific parturition grounds are not well established. Spawning time: Viviparous species.	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Thornback ray	*Raja clavata*	As above. Spawning time: February – September (peak spawning: April – August).	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Spotted ray	*Raja montagui*	As above. Spawning time: May – July.	Not available	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Herring	*Clupea harengus*	Spawning habitat last dated in 2018 indicates small/none spawning populations of Herring. However, personal communication with D. Clarke (SEACAMS) positively identified spawning herring near Warrior Way (site 6) Spawning time: January – March.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area.	0
Cod	*Gadus morhua*	High intensity spawning grounds within the fish and shellfish study area.	0	Low intensity nursery habitat found to the west of the fish and shellfish study area.	0.25
Whiting	*Merlangius merlangus*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – June.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area	0
Ling	*Molva molva*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – May.	0	Low intensity nursery habitat found to the west of the fish and shellfish study area.	0.25
European hake	*Merluccius merluccius*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: January – June.	0	Low intensity nursery habitat coinciding with the fish and shellfish study area	0
Anglerfish	*Lophius piscatorius*	Low intensity spawning habitat coinciding within the fish and shellfish study area. Spawning time: February – June.	0	As above.	0
Horse mackerel	*Trachurus trachurus*	Low intensity spawning habitat found within the fish and shellfish study area.	0	Not data available	Not data available

Species	Latin / scientific name	Spawning habitats		Nursery habitats	
		Description	Distance to fish and shellfish study area (km)	Description	Distance to fish and shellfish study area (km)
		Spawning time: March – August (Peak Spawning: May – June).			
Sandeel	*Ammodytidae*	High intensity spawning habitat found within the fish and shellfish study area. Spawning time: November – March.	0	Low intensity nursery habitat within the fish and shellfish study area.	0
Mackerel	*Scomber scombrus*	Low intensity spawning habitat found within the fish and shellfish study area. Spawning time: March – July.	0	As above.	0
Plaice	*Pleuronectes platessa*	Low intensity spawning habitat found within the fish and shellfish study area. High intensity habitat can be found to the south of the fish and shellfish study area (out with the study area). Spawning time: December – March.	0	As above.	0
Sprat	*Sprattus sprattus*	Low intensity spawning habitat found within the fish and shellfish study area. Spawning time: May – August (Peak Spawning: May – June).	0	Nursery areas have been identified throughout the Waterway. Overlaps the fish and shellfish study area	0
Sole	*Solea solea*	Low intensity spawning habitat found within the fish and shellfish study area. High intensity habitat can be found to the south of the fish and shellfish study area. Spawning time: March – May.	0	High intensity nursery habitat can be found within the fish and shellfish study area.	0
Nephrops		Low density spawning habitat found adjacent to the north west corner (at the 12 NM contour) of the fish and shellfish study area. Spawning time: January – December (Peak spawning: April – June).	Minimal overlap	Low intensity nursery habitat adjacent to the north west corner (at the 12 NM contour) of the fish and shellfish study area	Minimal overlap

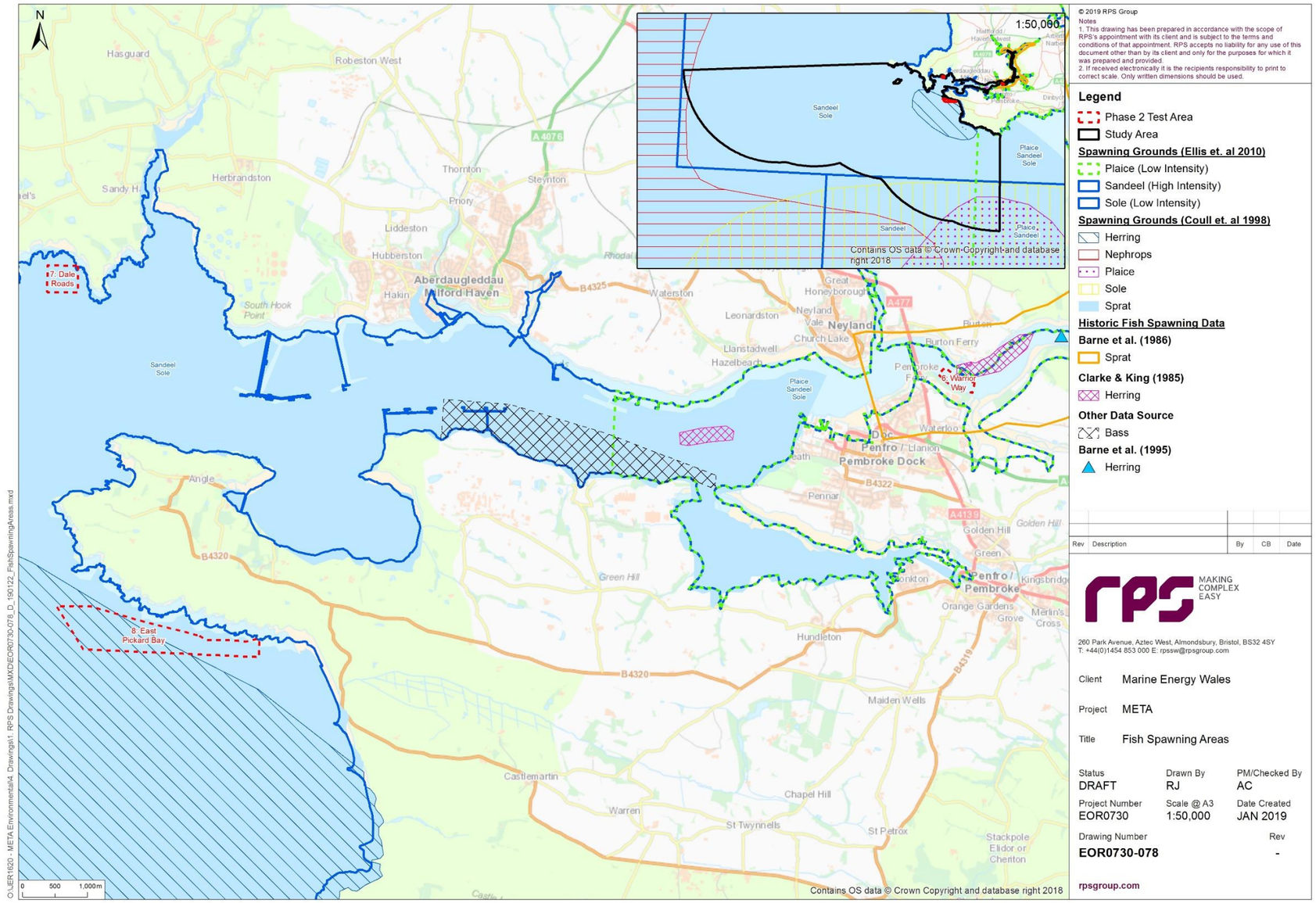

Figure 8.3: Spawning grounds within the fish and shellfish study area.

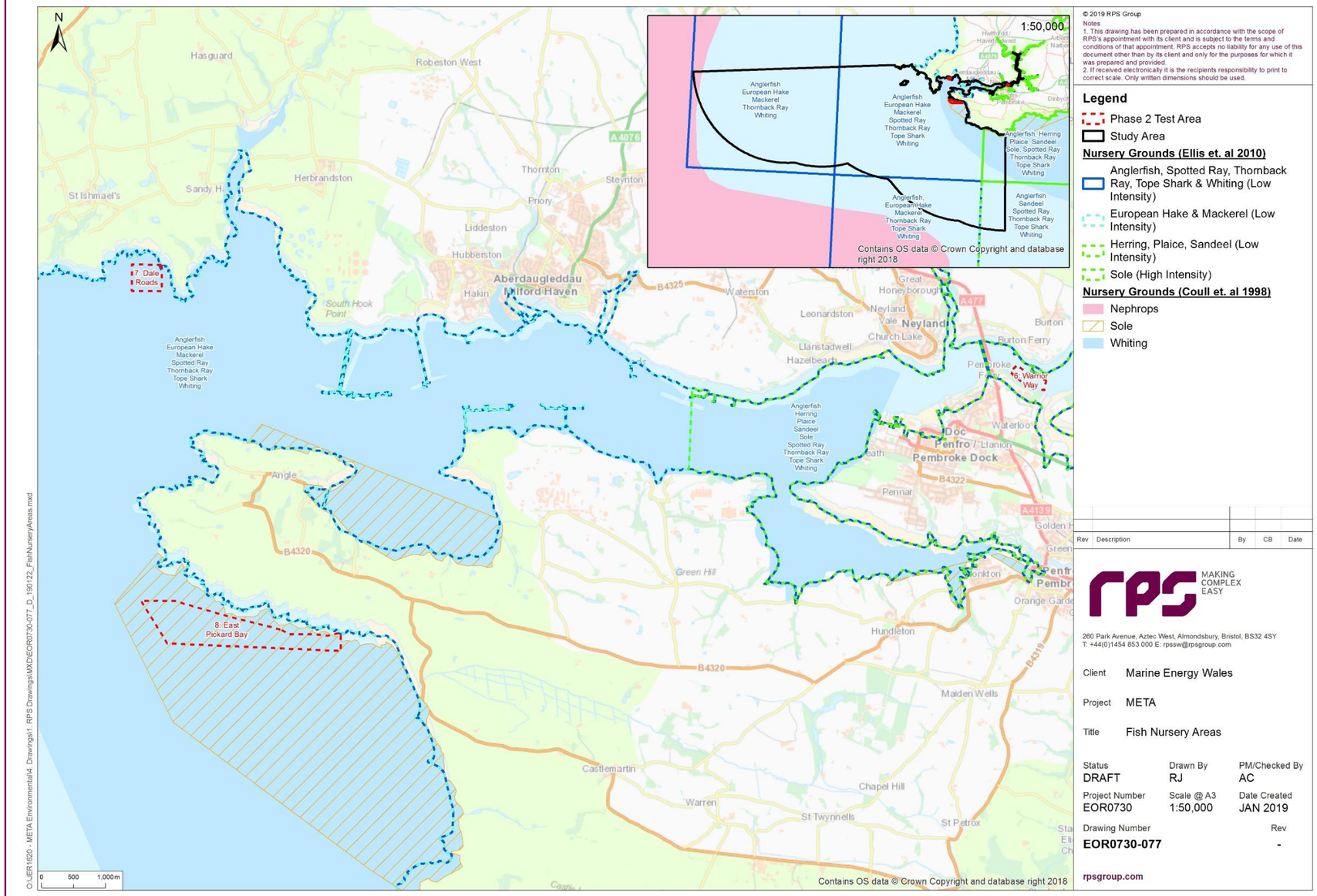

Figure 8.4: Nursery grounds within the fish and shellfish study area.

8.7.4 Local Shellfish Assemblage

8.7.4.1 Historically, the fish and shellfish study area has been harvested for cockles and Pacific oyster *Crassostrea gigas*, and in recent years the fisheries market has grown to include permits for carpet shell clams *Venerupis corrugata*, razors *Pharidae* spp. and native oysters *Ostrea edulis,* with aquaculture sites located off Swansea, Angle Bay and Castlebeach Bay. The large area and diverse marine habitats and sediment types has resulted in a variety of shellfish species including the native oyster, edible mussels *Mytilus edulis*, lobsters *Homarus gammus* and prawn *Palaemon serratus,* some of which have conservation and commercial value (see chapter 11: Commercial Fisheries).

8.7.4.2 The DDV survey undertaken at the East Pickard Bay (site 8), in June 2018 recorded shellfish assemblages of brown/edible crab *Cancer pagurus*, spiny spider crab *Maja squnado*, Portunida (includes swimming crabs). Pawson *et al.* (2002) describe the Pembrokeshire coast as a valuable potting ground. Potting for lobster, green shore crab *Carcinus maenas*, spider crab and velvet crab *Necora puber* is common in the fish and shellfish study area. Lobsters can be found as high up-stream as Lawrenny Quay and have been noted as breeding, with evidence of the populations extending as far as Lundy in the Bristol Channel.

Native Oyster

8.7.4.3 Due to the specificity and sensitivity of the native oyster, it 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.

8.7.4.4 Native oysters are found throughout the fish and shellfish study area with stocks present from Milford Haven town up to Picton Point. Native oyster beds found upstream of the Cleddau Bridge from Burton to Llangwm were sufficiently productive to support a historic fishery and were dredged commercially, especially at the known points of relative abundance at Lawrenny, Beggars Reach and Black Tar (Hobbs and Morgan, 1992). However, no permits for collection of native oysters have been awarded within the Waterway since 2010 (PNP, 2017), to allow recovery of shellfish stocks, except for two aquaculture sites which have been awarded permits in 2019 (see section 8.13 *et seq.* for more information).

Edible Mussel

8.7.4.5 Edible mussel beds are classed as a UK BAP Priority Habitat and currently on the OSPAR List of threatened and/or declining species and habitats. *Mussel* beds can also be key features of habitats listed in Annex I of the Habitats Directive. Wild stocks are present in patches throughout the fish and shellfish study area, either present on rocky shores or raised beds acting as 'nursery' areas for larvae. The main raised beds are found between the Cleddau Bridge and Picton Point at Lawrenny Quay, Coedcanlas and Sprinkle Pill. Jenkins Point, at the confluence of the Daugleddau the Carew and the Creswell Rivers, and Mount Pleasant are both Class B mussel beds (see Chapter 13: Commercial fisheries).

Spider Crab

8.7.4.6 Spider crabs have been recorded within the fish and shellfish study area, from Angle Bay up to Milford Haven Dock, with sightings around the coast of Pembrokeshire. Spider crabs generally feed on algae present on rocky substrata.

Velvet Crab

8.7.4.7 The velvet crab is a commonly occurring species whose distribution ranges from the lower intertidal/sublittoral fringe to depths of 80 m on rocky substrata (Clark, 1986). The species has an affinity for rocky substrata and is widespread around the UK coastline. Therefore, it is reasonable to assume that the species will occur in the fish and shellfish study area.

Green Crab

8.7.4.8 Green (shore) crabs can be found on all types of shores, from high water to depths of 60 m. Green crabs have been found throughout the year in the fish and shellfish study area and are abundant intertidally come spring. Shrimp have also been found on the seafloor, up to Lawrenny Quay.

Shellfish Waters

8.7.4.9 The EU Food Hygiene Regulations (852/2004, 853/2004 and 854/2004) are implemented in Wales through the Food Hygiene (Wales) Regulations 2006 (SI 2006/31) which came into force 11 January 2006. In accordance with the Regulations, bivalve production areas are classified according to the level of treatment they require prior to their sale. Local authorities collect this information and send it to the Centre for Environment, Fisheries and Aquaculture Science (CEFAS), who manage the program on behalf of the Food Standards Agency, who compile the data. Standards are set in terms of concentrations of coliform bacteria and Salmonella. Harvesting sites are classified from A to C, where Grade A sites do not require pre-treatment and grade C sites require intensive purification. A fourth category exists, from which harvesting is prohibited (Figure 8.5).

8.7.4.10 The EC Shellfish Waters Directive (79/923/EEC), adopted 30 October 1979, aims to protect or improve shellfish waters in order to support shellfish life and growth, therefore contributing to the high quality of shellfish products directly edible by man. There are two areas within the Waterway that have been designated as shellfish waters under this directive. The waters within the Carew river were designated shell fish waters from 11th October 1999. The Milford Haven Cleddau (east and western Cleddau rivers) was also designated in 1999, however, following a review of designations in 2003/2004, the area was extended in March 2004.

8.7.4.11 Historically, the Waterway has been harvested for wild cockles and Pacific oyster and in recent years the fisheries market has grown to include permits for carpet shell clams, razors. and native oysters. The large area, diverse marine habitats and sediment types, results in a variety of shellfish species. These include the native oyster, mussels, lobsters and prawn, some of which have conservation and commercial interests.

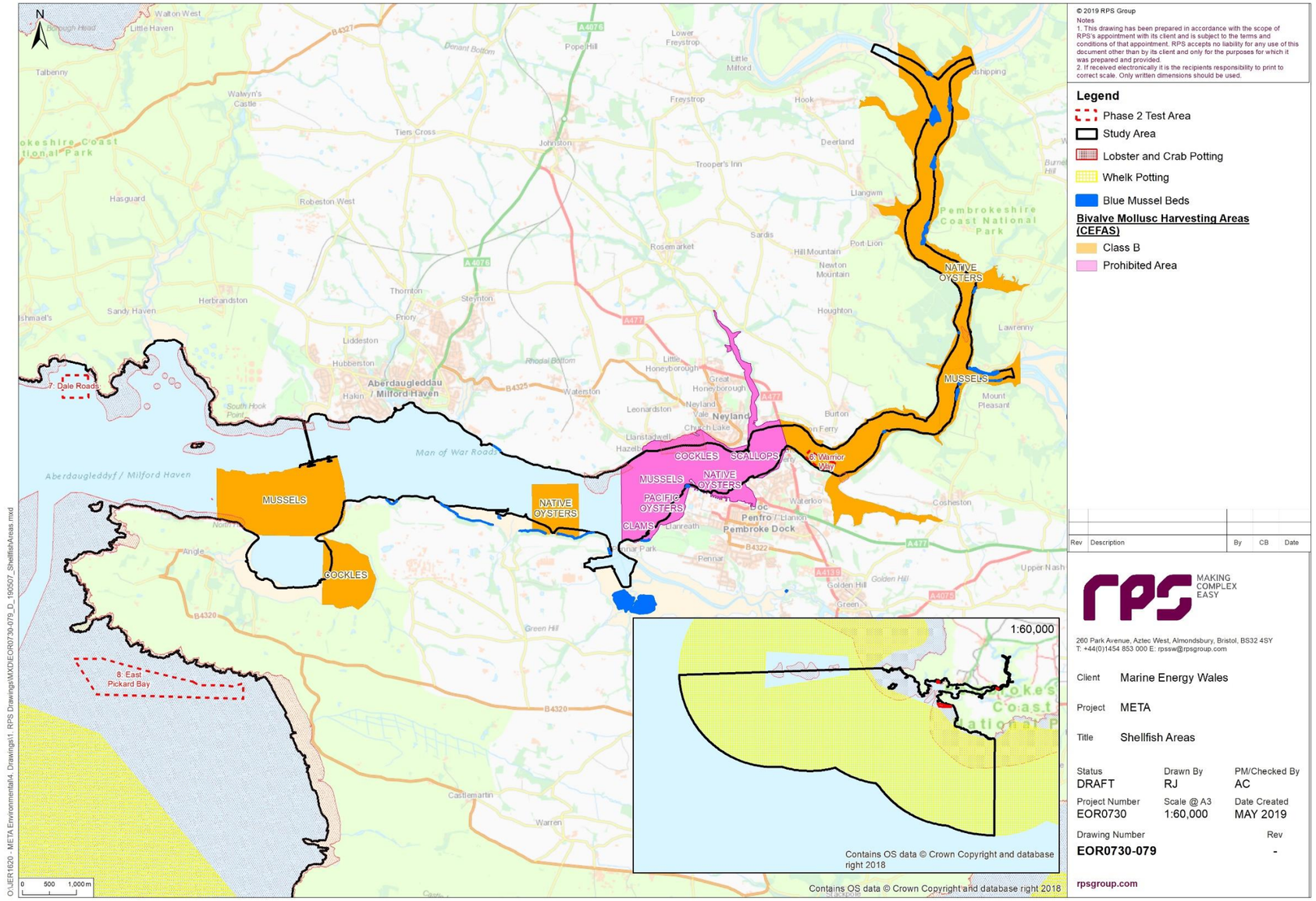

Figure 8.5: Shellfish areas within the fish and shellfish study area. Species identified which may be harvested within each Class B Bivalve Mollusc Harvesting Area (orange) are listed under each area identified. The area identified as a Prohibited Bivalve Mollusc Harvesting Area (pink), the species listed within this pink area may not be harvested at any time.

8.7.5 Trends in abundance

8.7.5.1 Interrogation of landings data reveals that the amount of fish and shellfish taken from the fish and shellfish study area has on average remained constant during throughout 2009 – 2017 (Figure 8.6). The decline in landed weight in 2009 – 2010 may have been due to the implementation of the Marine and Coastal Access Act 2009, allowing for better management of the South Wales fisheries and therefore a reduction in landed weight (see Chapter 11: Commercial Fisheries for more information on fishing effort). From 2010 onwards, the observed trend oscillates around a mean of 2600 tonne of fish and shellfish caught per year indicating a consistent stock of fish and shellfish population.

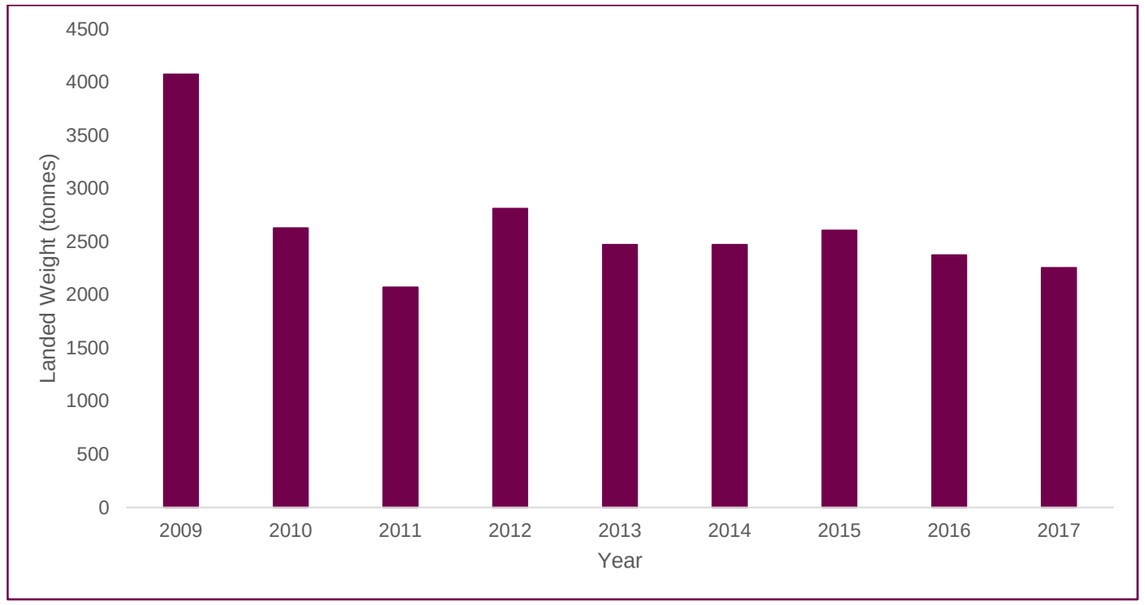

Figure 8.6: Total landings of fish and shellfish from the UK fleet landings per year (ICES rectangle 32E4 and 32E5).

8.7.6 Designated sites

8.7.6.1 Designated sites which have fish and shellfish notified interest features and which have been considered in the fish and shellfish assessment are described in Table 8.8 below. The META Habitat Regulations Assessments (HRA): Stage 1 Screening Report (HRA Report) details how sites and features have been screened into the need for HRA (with the assessment on the site itself deferred to the META project Report to Inform Appropriate Assessment (RIAA)).

[2] Species are only present within a freshwater environment, therefore no route to impacts.

Table 8.8: Designated sites and relevant qualifying interest features for the META project fish and shellfish assessment (light grey indicates species scoped out based on species ecology[2]).

Designated Site	Closest Distance to META sites (km)			Relevant Qualifying Interest Feature
	Warrior Way (site 6)	Dale Roads (site 7)	East Pickard Bay (site 8)	
Pembrokeshire Marine/ Sir Benfro Forol SAC	0	0	0	Sea lamprey *Petromyzon marinus*[1]; River lamprey *Lampetra fluviatilis*[1]; Allis shad *Alosa alosa*[1]; and Twaite shad *Alosa fallax*[1]
Cleddau Rivers/ Afonydd Cleddau SAC	11	16	17	Brook lamprey *Lampetra planeri*[1]; River lamprey *Lampetra fluviatilis*[2]; Bullhead *Cottus gobio*[2]; and Sea lamprey *Petromyzon marinus*[1]
Milford Haven Waterway SSSI	0	< 0.1	2.2	Oyster beds on shallow subtidal muddy sediment
Skomer Marine Conservation Zone	20.3	6.6	9.1	King scallop (*Pecten maximus*); Crawfish *Palinurus elephas*; Sunfish *Mola mola*.

[1] Annex II species present as a qualifying feature, but not a primary reason for site selection
[2] Annex II species that are a primary reason for selection of this site

8.7.7 Valued Ecological Receptors

8.7.7.1 The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2016). Based on the Chartered Institute for Ecology and Environmental Management (CIEEM, 2016) guidelines for determination of VER, the following VER category definitions have been utilised (Table 8.9).

Table 8.9: Valued Ecological Receptors Categorisation for fish and shellfish.

Value of VER	Criteria to define value
Very high	• Internationally designated sites. • Species protected under international law (i.e. Annex II species listed as features of SACs).
High	• Nationally designated sites. • Species protected under national law. • Annex II species which are not listed as features of SACs in the fish and shellfish study area.

Value of VER	Criteria to define value
	• Nationally important populations of a species (particularly within the context of species that may be rare or threatened within the UK[a]) that occur within the fish and shellfish study area such as: UK BAP priority species (including grouped action plans) that continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework; MCZ/rMCZ features (species classified as features of conservation importance and broad scale habitats), NERC species of principal importance in Wales, or NIMF • Species that have spawning or nursery areas within the fish and shellfish study area that are important nationally (e.g. may be primary spawning/nursery area for that species).
Medium	• Regionally important populations of a species (particularly within the context of species that may be rare or threatened within the UK) that occur within the fish and shellfish study area such as: UK BAP priority species (including grouped action plans) that continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework, MCZ/rMCZ features (species classified as features of conservation importance and broad scale habitats), NERC species of principal importance in Wales or NIMF. • Species that are of commercial value to the fisheries which operate within the fish and shellfish study area. • Species that form an important prey item for other species of conservation or commercial value and that are key components of the fish assemblages within the fish and shellfish study area. • Species that have spawning or nursery areas within the fish and shellfish study area that are important regionally (i.e. species may spawn in other parts of the UK but that this is key spawning/nursery area within the fish and shellfish study area as the region of interest).
Low	• Species that are of commercial importance but do not form a key component of the fish assemblages within the fish and shellfish study area (e.g. they may be exploited in deeper waters outside the fish and shellfish study area). • The spawning/nursery area for the species are outside the fish and shellfish study area. • The species is common throughout the UK but forms a component of the fish assemblages in the fish and shellfish study area.

[a] Measured against criteria such as OSPAR threatened/declining species and IUCN Red List of threatened species.

8.7.7.2 Based on the baseline characterisation above, a number of Valued Ecological Receptors (VER) were identified within the fish and shellfish study area. These have been amalgamated into VER groupings of similar/representative species and are presented in Table 8.10 and Table 8.11. Justification for these groupings are also provided in these tables. The species factors considered as part of the VER assessment include:

- Populations present within the fish and shellfish study area, based on commercial fisheries landing data were available (chapter 11: Commercial Fisheries);
- Spawning or nursery grounds within the study area;
- Conservation value within the study area; and
- Commercial value within the study area.

Table 8.10: Fish ecology VERs in the fish and shellfish study area.

Fish VERs	Representative species	Value within the study area	Justification
Estuarine fish assemblage	• Gobies • Dab • Mullet • Sand smelt • Sea bass • Flounder • Solenette • Lesser spotted dogfish • Catshark	Low	Species that form a key component of the ecosystem: no specific protection although some species may be commercially valuable to local fisheries
	• Plaice • Cod • Herring	Medium	Wales BAP priority species commonly found in the region
	• Thornback ray • Tope shark	Medium	Regionally important population of Annex II species also listed as OSPAR threatened or declining species and UK BAP Priority species.
Migratory fish species	• Sea trout • European eel • Atlantic salmon	High	OSPAR threatened or declining species and UK BAP Priority species.
	• Allis shad • Twaite shad • River lamprey • Sea lamprey	Very high	Annex II species protected under international legislation and designated features of the Pembrokeshire SAC and/or the Cleddau Rivers SAC
Spawning or nursery grounds in the study area	• Common skate • Blue whiting • Blue ling • Ling • Horse mackerel	Low	Spawning or nursery grounds in wider region but no overlap with fish and shellfish study area.
	• Hake • Anglerfish • Herring • Mackerel • Plaice • Whiting • Sprat • Tope shark • Thornback ray • Spotted ray	Medium	Low intensity spawning, or nursery habitat overlaps the fish and shellfish study area.
	• Cod • Sole • Sandeel	High	High intensity spawning, or nursery habitat overlaps the fish and shellfish study area.

Table 8.11: Shellfish ecology VERs in the fish and shellfish study area.

Shellfish VERs	Representative species/habitats	Value within the study area	Justification
Designated shellfish waters	• Cleddau Rivers (Eastern and Western) • Carew River	High	Areas designated to protect the quality of shellfish waters under the EC Shellfish Waters Directive
	• Native oyster (Oyster beds on shallow subtidal muddy sediment)	High	Designated feature of the Milford Haven waterway SSSI. Populations widespread through study area and commercially exploited; OSPAR threatened/declining species and UK/Wales BAP priority species
	• Mussel beds	Medium	Populations widespread through study area and commercially exploitation; OSPAR threatened/ declining species and UK/Wales BAP priority species
Estuarine shellfish assemblage	• Common cockle • Carpet shell clam • Common periwinkle • King scallop • European lobster • Spider crab • Velvet swimming crab • Green (shore) crab • Common prawn	Low	Commonly recorded within the Waterway but no conservation value. There may be some small-scale commercial exploitation of these species and Pembroke coast may be a valuable potting ground for decapod species.
Spawning or nursery grounds in the study area	• *Nephrops*	Low	Spawning or nursery grounds in wider region but only very slight overlap with fish and shellfish study area at 12 NM contour to north west of study area.

8.7.8 Sensitivity to marine energy devices

8.7.8.1 The Scottish Marine Renewables SEA (Faber Maunsell, 2007) summarised the sensitivity of fish and shellfish species to impacts associated with marine devices. This data has been derived from the MarLIN website and the criteria for determining species sensitivity can also be found there.

- Sprat: Considered to be of medium sensitivity to temporary increases in suspended sediments;
- Sandeel: Considered to be of high sensitivity (spawning areas) to temporary changes in habitat, and low sensitivity to temporary increases in suspended sediments;
- Herring: Considered to be of high sensitivity (spawning areas) to temporary increases in suspended sediments.
- Salmon: Considered to be of low sensitivity to temporary increases in suspended sediments;
- Lamprey: Sensitivity is unknown;
- Shad: Sensitivity is unknown;
- Brown (edible) crab: Considered to be of medium sensitivity to temporary changes in habitat;
- Native Oyster: considered to be of high sensitivity to temporary changes in habitat and temporary increases in suspended sediments;
- *Nephrops*: considered to be of medium sensitivity to temporary changes in habitat and temporary increases in suspended sediment; and
- Common whelk: considered to be of low sensitivity to temporary increases in suspended sediments.

8.7.9 Future baseline scenario

8.7.9.1 The (Marine Works (EIA) Regulations 2007 (as amended 2017)) requires that *"a description of the relevant aspects of the current state of the environment (baseline scenario), and an outline of the likely evolution thereof without implementation of the project, as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*" is included within the Environmental Statement.

8.7.9.2 In the event that the META project does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

8.7.9.3 Recent research has suggested that there have been substantial changes in the fish communities within the fish and shellfish study area over several decades, as a result of a number of factors including climate change and anthropogenic activities (i.e. industrialisation of the fish and shellfish study area, fishing, aquaculture etc.) (DECC, 2016a). These communities consist of species that have complex interactions with one another and the natural environment.

8.7.9.4 Fish and shellfish populations are subject to natural variation in population size and distributions, largely as a result of year to year variation in recruitment success, and these population trends will be influenced by broad-scale climatic and hydrological variations, as well as anthropogenic activities such as climate change and overfishing. Fish and shellfish play a pivotal role in the transfer of energy from some of the lowest to the highest trophic levels within the ecosystem and serve to recycle nutrients from higher levels through the consumption of detritus. Consequently, their populations will be determined by both top-down factors, such as ocean climate and plankton abundance, and bottom-up factors, such as predation. Fish and shellfish are important prey items for top marine predators including elasmobranchs, seabirds, marine mammals and humans. Small planktivorous species such as sandeel and herring act as important links between zooplankton and top predators (Frederiksen *et al.* 2006).

8.7.9.5 Climate change may influence fish distribution and abundance, affecting growth rates, recruitment, behaviour, survival and response to changes of other trophic levels. Within the fish and shellfish study area, increased sea surface temperatures may lead to an increase in the relative abundance of species associated with more southerly areas. For example, data on herring and sardine (*Sardina* sp.) landings at ports in the UK showed that higher herring landings were correlated with colder winters, while warm winters were associated with large catches of sardine (Alheit and Hagen, 1997). Studies have shown that anchovy *Engraulis encrasicolus* have extended their distribution throughout the UK waters, from which they were largely absent until the mid-1990s (Alheit *et al.,* 2012).

8.7.9.6 One potential effect of increased sea surface temperatures is that some fish species will extend their distribution into deeper, colder waters. In these cases, however, habitat requirements are likely to become important with some shallow water species having specific habitat requirements in shallow water areas which are not available in these deeper areas. For example, the sandeel is less likely to be able to adapt to increasing temperatures as a result of their specific habitat requirements for coarse sandy sediment; declining recruitment in sandeel in parts of the UK has been correlated with increasing sea temperature (Heath *et al*., 2012). Climate change may also affect key life history stages of fish and shellfish species, including the timing of spawning migrations (BEIS, 2016). However, climate change effects on marine fish populations are difficult to predict and the evidence is not easy to interpret, therefore it is difficult to make accurate estimations of the future baseline scenario for the entire lifetime (15 years) of the META project.

8.7.9.7 In addition to climate change, overfishing subjects many fish species to considerable pressure, reducing the biomass of commercially valuable species, and non-target species. Overfishing can reduce the resilience of fish and shellfish populations to other pressures, including climate change and other anthropogenic impacts. For example, a study on cod in an area where trawl fishing has been banned since 1932 indicated that this population was significantly more resilient to environmental change (including climate change) than populations in neighbouring fished areas (Lindegren *et al.*, 2010). Converse modelling by Beggs *et al.* (2013) indicated that cod may be more sensitive to climate variability during periods of low spawning stock biomass. There are indications that overfishing in UK waters is reducing to some degree, with declines in fishing mortality estimates in recent years. ICES guidance suggests that some of the stocks are recovering, with increased quotas for several species in 2018 (see http://www.ices.dk/community/advisory-process/Pages/Latest-advice.aspx). OSPAR's Quality Status Report (OSPAR, 2010) concluded that many fish stocks are still outside safe biological limits, although there have been some improvements in some stocks. Should these improvements continue, this may not result in significant changes in the species assemblage in the fish and shellfish study area but may result in increased abundance of the characterising species present in the area. Therefore, it is predicted that the future baseline scenario of the fish and shellfish study area will most likely result in increases in abundance as per the OSPAR Quality Status Report.

8.7.9.8 The fish and shellfish baseline characterisation described in the preceding sections represents a 'snapshot' of the fish and shellfish assemblages of the fish and shellfish study area, within a gradual and continuously changing environment. Any changes that may occur during the lifetime of the project (i.e. installation, operation and maintenance and decommissioning) should be considered in the context of the natural variability and anthropogenic effects, including climate change, overfishing and other environmental impacts.

8.7.10 Data limitations

8.7.10.1 Mobile species, such as fish, exhibit varying spatial and temporal patterns. All survey data across the fish and shellfish study area that has been utilised in the baseline characterisation, provides a semi-seasonal description of the fish and shellfish assemblages. However, this may vary considerable over time. In addition to this, survey methods employed may vary in their efficiency to catch species (i.e. otter trawls for pelagic species versus a benthic trawl for sandeels and prawn).

8.7.10.2 The desk-based review indicated the presence of fish and shellfish species within the fish and shellfish study area and whether spawning and nursery behaviour occurs. The following assumptions have been made:

- Spawning and nursery habitat data spatially and temporally varies over time (Ellis *et al.,* 2012), with data only being available at a very coarse level. It has therefore been assumed that if the fish and shellfish study area overlap with either habitat, then fish are present, unless evidence suggests otherwise (i.e. incompatible ecological parameters e.g. freshwater species in marine environments); and
- Migratory patterns of fish and shellfish species are not clearly defined in available literature. Where available evidence suggest presence, it is assumed that the species is present.

8.7.10.3 Any data limitations outlined above will not affect the conclusions of the impact assessment however, the assessment recognises the uncertainty regarding the potential impacts from tidal devices on fish and shellfish receptors.

8.8 Key parameters for assessment

8.8.1 Maximum and most likely design scenario

8.8.1.1 The maximum design scenarios identified in Table 8.12 have been selected as those having the potential to result in the greatest potential effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in the project description (chapter 2: Project Description). Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the project design envelope (e.g. different infrastructure layout) to that assessed here be taken forward in the final design scheme.

8.8.1.2 The most likely design scenarios identified in Table 8.12 have been selected as those having the potential to result in the most likely effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in the project description (chapter 2: project description).

8.8.1.3 A report by Freeman *et al.* (2013) for the Natural Environment Research Council, identified the key potential impacts on fish and shellfish from wave and tidal devices from full scale devices currently installed/operating in UK waters. Key impacts identified were 'barrier effects on movement and migration' (wave and tidal devices), 'underwater collision' (primarily tidal devices) and 'habitat creation' (wave and tidal devices) in Table 8.12 and 'underwater noise' (primarily tidal devices), and 'EMF emissions' (primarily tidal devices) in Table 8.13.

8.8.1.4 Impacts included within the 'META Scoping Report', such as 'sediment deposition' for the fish and shellfish chapter have been amalgamated into the 'temporary increases in suspended sediments' impact. In addition, 'tidal turbine collision risk at Warrior Way (site 6)' and 'physical barrier to movement of known migratory routes due to presence of tidal devices' impacts have been included for the operation and maintenance phase of the META project.

8.8.1.5 The fish and shellfish assessment will be used to inform the following assessments:

- Chapter 9: Marine Mammals, Basking Shark and Otter;
- Chapter 10: Marine Ornithology; and
- Chapter 11: Commercial Fisheries.

8.8.1.6 The fish and shellfish assessment have been informed by the following assessments:

- chapter 5: Coastal Processes; and

- chapter 7: Benthic Subtidal and Intertidal Ecology.

8.8.2 *Impacts scoped out of the assessment*

On the basis of the baseline environment and the project description outlined in chapter 2: Project Description, a number of impacts are proposed to be scoped out of the assessment for fish and shellfish. These impacts are outlined, together with a justification for scoping them out, in Table 8.13.

Table 8.12: Maximum and most likely design scenarios considered for the assessment of potential impacts on fish and shellfish[3].

Potential impact	Maximum design scenario	Most likely design scenario	Justification
Installation and decommissioning phases			
Temporary changes in fish and shellfish habitat	• Up to 150 installation events occurring intermittently over the 15-year lifetime of the META project, 50 % of which may touch the seabed. – Warrior Way: up to four device deployments in a 12-month period (i.e. up to 60 deployments over the project lifetime), 50 % of which may touch the seabed; – Dale Roads: up to two device deployments in a 12-month period (i.e. up to 30 deployments over the project lifetime), 50% of which may touch the seabed; and – East Pickard Bay: up to two device deployments in a 12-month period at each berth therefore up to four device deployments in a 12-month period (i.e. up to 60 deployments over the project lifetime), 50% of which may touch the seabed. • Combined (Warrior Way + Dale Roads + East Pickard Bay) total subtidal temporary habitat disturbance at any one time of up to 124,679 m^2 comprising: – Up to 480 m^2 of temporary disturbance at Warrior Way per testing scenario broken down as follows: ○ Up to 330 m^2 from a 5 m buffer around device footprint (200 m^2) for seabed clearance activities; and ○ Up to 150 m^2 from a single mooring spread for deployment vessels. – Up to 713 m^2 of temporary disturbance at Dale Roads per testing scenario broken down as follows: ○ Up to 513 m^2 from a 5 m buffer around device footprint (600 m^2) for seabed clearance activities; and ○ Up to 200 m^2 from a single mooring spread for deployment vessels. – Up to 123,486 m^2 of temporary disturbance at East Pickard Bay per testing scenario broken down as follows: ○ Up to 3,485 m^2 from a 10 m buffer around device footprint (8,000 m^2) for seabed clearance activities; and ○ Up to 120,000 m^2 from mooring spread for deployment vessels for up to two test activities at any one time. • A total of up to 160 test installation and removal vessel movements (which may involve anchoring) in a 12-month period broken down as follows: – up to 20 installation and 20 retrieval vessel movements in a 12-month period at Warrior Way (site 6) and Dale Roads (site 7). – up to 40 installation and 40 retrieval vessel movements in a 12-month period at East Pickard Bay (site 8).	• Up to 60 installation events occurring intermittently over the 15-year lifetime of the META project. – Warrior Way: up to two device deployments in a 12-month period (i.e. up to 30 deployments over the project lifetime), 50 % of which may touch the seabed; – Dale Roads: up to one device deployments in a 12-month period (i.e. up to 15 deployments over the project lifetime) 50 % of which may touch the seabed; and – East Pickard Bay: up to one device deployments in a 12-month period (i.e. up to 15 deployments over the project lifetime) 50 % of which may touch the seabed. • Combined (Warrior Way + Dale Roads + East Pickard Bay) total subtidal temporary habitat disturbance of up to 70,175 m^2 comprising: – Up to 75 m^2 of temporary disturbance at Warrior Way from a single mooring spread for deployment vessels at any one time; – Up to 100 m^2 of temporary disturbance at Dale Roads from a single mooring spread for deployment vessels at any one time; and – Up to 70,000 m^2 of temporary disturbance at East Pickard Bay from mooring spread for deployment vessels per test activity. • A total of up to 120 test installation and removal vessel movements (which may involve anchoring) in a 12-month period broken down as follows: – up to 20 installation and 20 retrieval vessel movements in a 12-month period at each site.	The introduction of hard structures, such as marine energy devices, gravity base, and rock ballasting, have the potential to result in temporary habitat loss, disturbance or creation. The structures will be placed directly on the seafloor, resulting in potential changes to fish and shellfish supporting habitat. Hard structures also represent a novel substrate for pioneer species to recruit to. This can result in new species communities forming, representing a potential positive effect on fish and shellfish by providing potential new supporting habitat. These parameters are considered to represent the maximum and most likely design scenarios with respect to effects on benthic receptors from habitat loss during the installation phase. <u>Maximum design scenario</u> The maximum design scenario assumes that the footprint beneath the device/component is considered as habitat change for the duration of the deployment. The maximum design scenario assumes the greatest habitat change is associated with the presence of gravity base mooring systems rather than pin piles. There will be no requirement for drilling to install pin piles at Warrior Way (site 6). Rock ballasting may be required for scour protection/moorings of devices at East Pickard Bay (site 8) assuming up to 100 rock bags each with a diameter of up to 2 m. However, rock ballasting will only be placed directly on the device footprint, therefore representing no further loss of habitat. <u>Most likely design scenario</u> The maximum design scenario assumes that the footprint beneath the device/component on the seabed is considered as habitat change for the duration of the deployment. The most likely design scenario assumes that gravity bases may be required at Dale Roads (site 7) and East Pickard Bay (site 8), but not at Warrior Way (devices to be deployed from vessel or attached to test support buoy).
Temporary increases in suspended sediments	• As per Temporary changes in fish and shellfish habitat outlined above. • Drilling for pin pile installation as follows:	• As per Temporary changes in fish and shellfish habitat outlined above	Installation of artificial structures in fine sediment may result in sediment plumes. This will be dependent on the methodology of installation. Vessel movement associated with device deployment may also result in suspended sediments through propeller backwash.

[3] Impacts "Sediment deposition" identified in the META scoping report has been assessed as part of "Temporary increases in suspended sediments", and "removal of hard structures" has been assessed in "Temporary changes in fish and shellfish habitat".

Potential impact	Maximum design scenario	Most likely design scenario	Justification
	– Dale Roads: up to four pin piles per device. Each pin pile up to 100 mm diameter installed to a depth of 10 to 20 m; and • East Pickard Bay: up to four pin piles per device. Each pin pile up to 100 mm diameter installed to a depth of 10 to 20 m.	• No drilling for pin pile installation	These parameters are considered to represent the maximum and most likely design scenarios with respect to effects on fish and shellfish receptors associated with increased suspended sediments.
Accidental Pollution	• A total of up to 160 test installation and removal vessel movements (which may involve anchoring) in a 12-month period broken down as follows: – Up to 20 installation and 20 retrieval vessel movements in a 12-month period at Warrior Way (site 6) and Dale Roads (site 7). – Up to 40 installation and 40 retrieval vessel movements in a 12-month period at East Pickard Bay (site 8).	• A total of up to 120 test installation and removal vessel movements (which may involve anchoring) in a 12-month period broken down as follows: – up to 20 installation and 20 retrieval vessel movements in a 12-month period at each site.	Installation of marine renewable devices may result in an unforeseen accidental pollution event. As an increase in the number of vessels or installation events may increase the potential of an accidental pollution event occurring, the maximum and most likely scenarios incorporates the maximum and most likely number of vessel movements associated with the installation and decommissioning of devices and components.
Operation and maintenance phase			
Colonisation of Hard Structures	• Warrior Way – Up to 20 m width and 10 m length. – Rotor diameter up to 5 m with a tip speed of up to 5 m/s and a swept area of 19.63 m^2 – Gravity base up to 25 m^2 – Maximum duration of moored/gravity base/device: up to 6 months • Dale Roads – Up to 30 m width and 20 m length. – Gravity base up to 500 m^2 – Maximum duration of moored/gravity base/device: up to 12 months • East Pickard Bay – Up to 147 m width and 230 m length. – Gravity base up to 1125 m^2 – Maximum duration of moored/gravity base: up to 18 months	• Warrior Way – Up to 5 m width and 5 m length. – Rotor diameter up to 5 m with a tip speed of up to 2 m/s and a swept area of 19.63 m^2 – No gravity base – deployed from vessel or test support buoy – Maximum duration of moored/gravity base/device: up to 3 months • Dale Roads – Up to 15 m width and 10 m length. – Gravity base up to 75 m^2 – Maximum duration of moored/gravity base/device: up to 6 months • East Pickard Bay – Up to 80 m width and 17 m length. – Gravity base up to 1125 m^2 • Maximum duration of moored/gravity base: up to 6 months	Introduction of a novel structure may lead to marine fauna and flora colonising these hard structures. These parameters are considered to represent the maximum and most likely design scenarios with respect to effects on benthic receptors from habitat loss during the operation and maintenance phase.
Medium term habitat loss	• Combined (Warrior Way + Dale Roads + East Pickard Bay) total subtidal habitat loss of up to 11,050 m^2 at any one time comprising: – Up to 200 m^2 of habitat loss at Warrior Way per testing scenario broken down as follows: ○ Up to 200 m^2 from device or component footprint on the seabed (including mooring/pin pile footprint). – Up to 600 m^2 of long-term habitat loss at Dale Roads per testing scenario broken down as follows: ○ Up to 600 m^2 from device or component footprint on the seabed (including mooring/pin pile footprint) – Up to 10,250 m^2 of habitat loss at East Pickard Bay broken down as follows: ○ Up to 10,250 m^2 from up to two device or component footprints on the seabed (including mooring/pin pile footprint). • Deployment durations:	• Combined (Warrior Way + Dale Roads + East Pickard Bay) total subtidal habitat loss of up to 2,000 m^2 at any one time comprising: – Up to 100 m^2 of habitat loss at Warrior Way per testing scenario from device or component footprint on the seabed; – Up to 200 m^2 of habitat loss at Dale Roads per testing scenario from device or component footprint on the seabed; – Up to 1,700 m^2 of habitat loss at East Pickard Bay per testing scenario from device or component footprint on the seabed. • Deployment durations: – Moored/gravity base deployment duration at Warrior Way: up to 3 months;	The longest consented length for a structure to be in the marine environment at each site will represent the maximum period of time that could lead to habitat loss. The most likely scenario for duration of a structure in the marine environment will represent the most likely loss of habitat. These parameters are considered to represent the maximum and most likely design scenarios with respect to effects on benthic receptors from habitat loss during the operation and maintenance phase.

Potential impact	Maximum design scenario	Most likely design scenario	Justification
	– Moored/gravity base deployment duration at Warrior Way: up to 6 months; – Moored/gravity base deployment duration at Dale Roads: up to 12 months; and – Moored/gravity base deployment duration at East Pickard Bay: up to 18 months.	– Moored/gravity base deployment duration at Dale Roads: up to 6 months; and – Moored/gravity base deployment duration at East Pickard Bay: up to 6 months.	
Tidal turbine collision risk at Warrior Way (site 6)	• Tidal device testing will only be supported at Warrior Way (site 6). • Tidal components may occupy all or part of the water-column. A minimum clearance of 2 m will be maintained between turbine blade tips and the surface of the water. • Up to 20 m width and 10 m length. • Rotor diameter up to 5 m. with a tip speed of up to 5 m/s and a swept area of 19.63 m^2	• Tidal device testing will only be supported at Warrior Way (site 6). • Tidal components may occupy all or part of the water-column. A minimum clearance of 2 m will be maintained between turbine blade tips and the surface of the water. • Up to 5 m width and 5 m length. • Rotor diameter up to 5 m, with a tip speed of up to 2 m/s and a swept area of 19.63 m^2	During the operation of tidal turbines, there is a potential for fish collision risk. This arises due to the nature of the turbine blades utilising tidal energy to spin the turbine blades. Alternatively, eddies can form at the tips of the turbine blades, stressing fish species. The maximum swept area within the water column will present the maximum scenario for potential collision risk. The swept area is the same for both maximum and most likely scenarios.
Physical barrier to movement of known migratory routes due to presence of tidal devices at Warrior Way (site 6)	• As per Tidal turbine collision risk at Warrior Way (site 6) above.	• As per Tidal turbine collision risk at Warrior Way (site 6) above.	Tidal turbine(s) represent a potential direct physical barrier to migratory fish movement, species of which are known to occur within Warrior Way (site 6). The maximum swept area within the water column will present the maximum scenario for potential physical barrier to movement. The swept area is the same for both maximum and most likely scenarios
Accidental Pollution	• Physical presence of single devices or components at the Warrior Way (site 6) and Dale Roads (site 7) sites and up to two devices or components at the East Pickard Bay (site 8) site. • A total of up to 358 vessel movements/round trips to port, involving up to 15 vessels, associated with test deployments per year comprising: – Up to 104 vessel movements/round trips to port, involving up to five vessels, associated with test deployments per year at the Warrior Way site; – Up to 104 vessel movements/round trips to port, involving up to five vessels, associated with test deployments per year at the Dale Roads site; and – Up to 150 vessel movements/round trips to port, involving up to five vessels, associated with test deployments per year at the East Pickard Bay site.	• Physical presence of single devices or components at the Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8) sites. • A total of up to 208 vessel movements/round trips to port, involving up to 15 vessels, associated with test deployments per year comprising: – Up to 52 vessel movements/round trips to port, involving up to three vessels, associated with test deployments per year at the Warrior Way site; – Up to 52 vessel movements/round trips to port, involving up to three vessels, associated with test deployments per year at the Dale Roads site; and – Up to 104 vessel movements/round trips to port, involving up to three vessels, associated with test deployments per year at the East Pickard Bay site.	The operation and maintenance of marine renewable devices may result in an unforeseen accidental pollution event. As an increase in the number of vessels or installation events may increase the potential of an accidental pollution event occurring, the maximum and most likely scenarios incorporate the maximum and most likely number of vessel movements associated with the operation and maintenance of devices and components.

Table 8.13: Impacts scoped out of the assessment for fish and shellfish.

Potential impact	Justification
Installation and Decommissioning Phases	
Underwater noise	There is potential for installation vessels, drilled piling and other equipment to produce noise during installation of the energy devices. The noise emissions from the types of vessels that may be used in the META Project are quantified in chapter 6: Underwater Noise, data are also presented for underwater pile drilling. Chapter 6: Underwater Noise shows the calculated ranges of injury to fish with swim bladders in line with ASA guidelines, based on exceedance of 170 dB re 1 µPa (rms) over 48 hours continuous exposure, and the potential disturbance radius to fish based on the WSDOT criterion of 150 dB re 1 µPa (rms). Fish with a swim bladder involved in hearing (maximum adverse) (Table 6.9 chapter 6; Underwater Noise) would have to be within 10 m of a noise source to have the potential for high risk of injury due to exposure to installation noise associated with the META project based on ASA qualitative criteria. The ASA radius of potential recoverable injury from continuous exposure over a 48-hour period is 0 m for drilled piling. This equates to a radius of potential disturbance zone of 6 m (all fish). SELs have been estimated for each source based on 24 hours continuous operation. It is important to note that it is highly unlikely that any fish would stay at a stationary location or within a fixed radius of a vessel (or any

Potential impact	Justification
	other noise source) for 24 hours. Consequently, any resulting injury zones should be treated as a very pessimistic, maximum scenarios. It is therefore not thought likely that any fish species will be injured as a result of installation activities associated with the META project. No pile drive pilling will be carried out at Warrior way (site 6) Dale Roads (site 7) or East Pickard Bay (site 8). Injury from drilled pin pilling may occur up to at 6 m from noise source. Behavioural disturbance may occur up to 37 m for all fish arising from noise generated from an installation vessel using dynamic positioning (DP). Warrior Way (site 6) at its narrowest points between MLWS and MLWS is circa 330 m. Fish may be disturbed at up to 37 m from noise source and are likely to use the remaining width of the Waterway. SELs for DP vessels have been recorded at 232 dB re 1 μPa^2s with miscellaneous small vessels at 221 dB re 1 μPa^2s, which currently transit the Waterway throughout the year (chapter 6: Underwater Noise). It is therefore unlikely that a significant change in fish behaviour will occur as any installation vessels will be in-situ short term, most likely resulting in fish moving away from the installation site and returning to the area following cessation of installation works.
Operation and maintenance phase	
Underwater noise	An assessment of the distance to onset of injury from each vessel category is presented in chapter 6: Underwater Noise based on the SEL cumulative exposure criterion, along with an assessment of potential disturbance zones. As noted previously, the potential radii for injury are based on exposure levels over a 24-hour period. In reality, an animal is highly unlikely to spend 24 hours within a short range of an operating device and the radii can therefore be considered as a maximum scenario, highly precautionary zone. The ASA radius of potential recoverable injury assuming continuous exposure within 48 hours is 0 m for a wave device (Pelamis P2), with an associated 6 m radius of disturbance. A tidal device (OpenHyrdo tidal turbine) may have a radius of potential recoverable injury of 4 m with an associated 78 m disturbance radius. Chapter 10: Underwater Noise concludes that, based on the ASA guideline criterion for potential injury to fish with swim bladders involved in hearing of 170 dB re 1 µPa (for 48 hours exposure), it is not expected that any fish will experience injury as a result of exposure to noise from the operation of marine energy devices.
Electromagnetic field (EMF)	There is no marine communications cable within the META project Design Envelope, therefore there is no potential for production of EMF.
Fish ingress	Following a review of the likely wave marine renewable devices to be installed at the META project (Appendix 2.1), fish ingress is unlikely to represent a significant impact to fish population due to the majority of these devices operating on a closed system i.e. all moving parts are closed off from the environment. For instance, one of the largest of the potential wave marine devices to be installed at East Pickard Bay (site 8), the Bombora mWave device, operates on the basis that there are no exposed moving parts (https://bomborawave.com/mwave). As part of the conditions of use of META sites Dale Roads (site 7) and East Pickard Bay (site 8) which are the two META project sites which may support wave energy converters, there will be a requirement that all wave energy converter devices are designed to minimise fish ingress, therefore fish ingress will be highly unlikely.

8.9 Impact assessment methodology

8.9.1 Overview

8.9.1.1 The fish and shellfish assessment has followed the methodology set out in chapter 4: Environmental Impact Assessment Methodology. Specific to the fish and shellfish assessment, the following guidance documents have also been considered:

- Consenting, EIA and HRA Guidance for Marine Renewable Energy Developments in Scotland. Part Four – Wave and Tidal Annex (EMEC and Xodus, 2010).

8.9.1.2 In addition, the fish and shellfish EIA has considered the legislative framework as defined by the Wildlife and Countryside Act 1981 (as amended), the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive), the Marine and Coastal Access Act, 2009, and the Conservation of Habitats and Species Regulations 2017 (consolidates and updates the Conservation of Habitats and Species regulations 2012).

8.9.2 Impact assessment criteria

Sensitivity

8.9.2.1 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude and are described in further detail in chapter 4: Environmental Assessment Methodology.

8.9.2.2 The criteria for defining sensitivity in this chapter are outlined in Table 8.14.

8.9.2.3 The sensitivity of fish and shellfish VERs has been determined by an assessment of the combined vulnerability of the receptor to a given impact, and the likely rate of recoverability to pre-impact conditions. Vulnerability is defined as the susceptibility of a species to disturbance, damage or death, from a specific external factor. Recoverability is the ability of the same species to return to a state close to that which existed before the activity or event which caused change. It is dependent on its ability to recover or recruit subject to the extent of disturbance/damage incurred. Information on these aspects of sensitivity of the fish and shellfish VERs to given impacts has been informed by the best available evidence. These assessments have been combined with the assessed status (i.e. the level of designation/importance resulting in a valuation) of the affected receptor presented in Table 8.9. The overall sensitivity of a receptor/receptor group to an impact has been identified from a five-point scale as presented in Table 8.14.

Table 8.14: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition
Very High	Very High or High VER with high vulnerability and no ability for recovery.
High	Medium VER with high vulnerability and no ability for recovery. Very High or High VER with high vulnerability and low recoverability.
Medium	Low VER with high vulnerability and no ability for recovery. Medium VER with medium to high vulnerability and low recoverability. Very High or High VER with medium vulnerability and medium recoverability.
Low	Low VER with medium to high vulnerability and low recoverability. Medium VER with low vulnerability and medium to high recoverability. Very High or High VER with low vulnerability and high recoverability.
Negligible	Receptor is not vulnerable to impacts regardless of value/importance. Low VER with low vulnerability and medium to high recoverability.

Magnitude

8.9.2.4 The criteria for defining magnitude in this chapter are outlined in Table 8.15.

Table 8.15: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (adverse).
	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (positive).
Moderate	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (adverse).
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (positive).
Minor	Some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements (adverse).
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of adverse impact occurring (positive).
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (adverse).
	Very minor benefit to, or positive addition of one or more characteristics, features or elements (positive).
No change	No change from baseline conditions.

Significance

8.9.2.5 The significance of the effect upon fish and shellfish is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in Table 8.16. Where a range of significance of effect is presented in Table 8.16, the final assessment for each effect is based upon expert judgement.

8.9.2.6 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 8.16: Matrix used for the assessment of the significance of the effect.

Sensitivity of receptor	Magnitude of impact: No change	Negligible	Minor	Moderate	Major
Negligible	Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
Low	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
Medium	Negligible	Negligible or minor	Minor	Moderate	Moderate or major
High	Negligible	Minor	Minor or moderate	Moderate or major	Major or substantial
Very high	Negligible	Minor	Moderate or major	Major or substantial	Substantial

8.9.3 Designated sites

8.9.3.1 Where Natura 2000 sites (i.e. internationally designated sites) are considered, this chapter summarises the assessments made on the interest features of internationally designated sites as described within section 8.7.6.1 of this chapter (with the assessment on the site itself deferred to the HRA Report for the META project).

8.9.3.2 With respect to nationally and locally designated sites, where these sites fall within the boundaries of an internationally designated site and where notified interest features of the Natura site are also qualifying interest features of the nationally designated sites (e.g. SSSIs which under-pin a Natura site), only the international site has been taken forward for assessment. This is because potential effects on the integrity and conservation status of the nationally designated site are assumed to be inherent within the assessment of the internationally designated site (i.e. a separate assessment for the national site is not undertaken). However, where a nationally designated site falls outside the boundaries of an international site, but within the fish and shellfish study area, an assessment of the impacts on the overall site is made in this chapter using the EIA methodology.

8.9.3.3 The RIAA has been prepared in accordance with Advice Note Ten: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (PINS, 2016) and will be submitted as part of the Marine Licence, Marine Works and Section 36 Licence applications.

8.10 Measures adopted as part of the META Project

8.10.1.1 As part of the project design process, a number of designed-in measures have been proposed to reduce the potential for impacts on fish and shellfish (see Table 8.17). As there is a commitment to implementing these measures, they are considered inherently part of the design of the META project and have therefore been considered in the assessment presented in section 8.11 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 8.17: Designed-in measures adopted as part of the META project.

Measures adopted as part of the META project	Justification
Avoidance of known sensitive areas for fish and shellfish in selection of META project sites.	Avoidance of known areas of sensitivity for fish and shellfish during the META site-selection process has reduced the potential for adverse effects on receptor species/VERs.
A Marine Pollution Contingency Plan (MPCP) will be produced and followed. The MPCP will cover the installation, operation and maintenance, and decommissioning phases of the META project and will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details and process to follow in the event of accidental spill.	Measures will be adopted to ensure that the potential for release of pollutants from installation, operation and maintenance, and decommissioning is minimised. In this manner, accidental release of potential release of contaminants from vessels will be strictly controlled, thus providing protection for marine life across all phases of the project development.
An Environmental Mitigation and Monitoring Plan (EMMP) will also be produced. The EMMP will outline the post consent monitoring requirements and mitigation measures for marine renewable devices at the META project. The EMMP will detail different monitoring and mitigation requirements for each generic device type to be deployed.	Measures will be adopted to ensure that the potential for any adverse impacts to environmental receptors are prevented, based on the predictions made in Chapter 7: fish and shellfish. Any known sensitive areas when installing marine devices will be avoided.

8.11 Assessment of significance

8.11.1.1 The potential impacts of the installation, operation and maintenance, and decommissioning of the META project have been assessed for fish and shellfish receptors. The potential impacts arising are listed in Table 8.12, along with the maximum and most likely design scenarios against which each potential impact has been assessed. An overall conclusion of significance of effect has been made for the META project (Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8)).

8.11.2 Installation phase

Temporary changes to fish and shellfish habitat

8.11.2.1 Installation activities such as device or navigational buoy anchoring, and the presence of marine energy devices in the water column, have the potential to result in temporary changes to habitat for fish and shellfish. Temporary changes to, or disturbance of habitat, may affect species both positively and negatively and these potential changes are outlined below.

8.11.2.2 The nature of marine renewable devices means that from installation through to decommissioning, devices will occupy an area of sea, resulting in a reduction water-column availability. Anchoring or attachment methods may also result in temporary disturbance to or loss of seabed habitat or compaction of sediment (i.e. during anchor placement or gravity base foundation placement). These changes have the potential to reduce the availability of marine habitat, including spawning, nursery or feeding habitats. These changes may result in a temporary reduction in fish and shellfish species abundance or diversity within affected areas, though demersal fish and shellfish species and demersal spawning species are likely to be affected to the greatest extent. Substratum loss will only directly affect species utilising the seabed, including shellfish and demersal species listed in Table 8.10 and Table 8.11, and a temporary reduction in sections of water column will only directly affect pelagic species.

8.11.2.3 Habitat disturbance also has the potential to result in the creation of new temporary habitats or feeding opportunities for fish and shellfish receptors. Intermittent disturbance to an environment has been found to increase species richness in local fish and shellfish populations, as described by the intermediate disturbance hypothesis (Wilkinson, 1999). Localised disturbance through periodic installation of marine energy devices may lead to species movement into disturbed areas, resulting in a periodic increase in species richness. Langhamer *et al.* (2009) concluded that wave and tidal devices and their ancillary structures have the potential to create new habitats by introducing novel surfaces for colonisation; preference for colonisation was found for vertical surfaces rather than horizontal ones. Species that may benefit from temporary disturbance include benthic and demersal fish species, and shellfish species.

Magnitude of impact

8.11.2.4 Habitat disturbance, in particular associated with gravity foundation placement preparation may result in temporary loss of habitat beneath deployment areas. Any mounding of sediments due to marine renewable device or ancillary structure placement is however expected to disperse in the relatively energetic marine areas and will re-join the naturally occurring sedimentary processes at the META project sites. Changes to habitat are therefore considered to be temporary and fish and shellfish VERs are expected to recolonise these areas rapidly.

8.11.2.5 The maximum scenario total temporary subtidal habitat disturbance of the anchoring and presence of devices on the seabed at all three META project sites is 124,679 m^2. For each site this equates to 480 m^2 (Warrior Way (site 6)), 713 m^2 (Dale Roads (site 7)) and 123,486 m^2 (East Pickard Bay (site 8)). The total area proposed for consent is 1,518,500 m^2 (Warrior Way (site 6) 93,000 m^2, Dale Roads (site 7) 195,500 m^2, East Pickard Bay (site 8) 1,230,000 m^2), therefore, the maximum total area of temporary habitat change or disturbance represents 8.18% of the total proposed META Project area (0.35% Warrior Way (site 6), 0.26% Dale Roads (site 7), 10.03% East Pickard Bay (site 8)).

8.11.2.6 The most likely scenario total seabed footprint for the anchoring and presence of devices on the seabed at all three META project sites is 70,175 m^2. For each site this equates to 75 m^2 (Warrior Way (site 6)), 100 m^2 (Dale Roads (site 7)) and 70,000 m^2 (East Pickard Bay (site 8)). The total area proposed for consent is 1,518,500 m^2 (Warrior Way (site 6) 93,000 m^2, Dale Roads (site 7) 195,565 m^2, East Pickard Bay (site 8) 1,230,000 m^2), therefore, the maximum total area of temporary habitat loss or disturbance represents 4.62% of the total proposed META Project area (0.08% Warrior Way (site 6), 0.10% Dale Roads (site 7), 5.69% East Pickard Bay (site 8)).

8.11.2.7 Both the maximum and most likely scenarios represent a very small proportion of available fish and shellfish habitat within the META project consented areas (8.18% and 4.62% respectively).

8.11.2.8 Devices and ancillary equipment such as navigational marker buoys will be placed in the marine environment; for the maximum scenario up to four device deployments in a 12-month period (Warrior Way (site 6)), two device deployments in a 12 month period (Dale Roads (site 7)), and up to two device deployments in a 12-month period at each berth therefore up to four device deployments in a 12-month period (East Pickard Bay (site 8)); and under the most likely scenario; up to two device deployments in a 12-month period (Warrior Way (site 6)), up to one device deployments in a 12-month period (Dale Roads (site 7)), and up to one device deployments in a 12-month period (East Pickard Bay (site 8)). Testing activities and therefore potential temporary changes to fish and shellfish habitat are considered therefore to be short/medium term duration, and intermittent.

8.11.2.9 The potential impact of temporary habitat changes from installation activities is therefore predicted to be of local spatial extent, short/medium term duration, intermittent and reversible. It is predicted that the potential impact may affect fish and shellfish receptors directly through loss of habitat, and indirectly through changes in prey availability. The magnitude is therefore considered to be minor (adverse/beneficial).

Sensitivity of the receptor

8.11.2.10 Many of the species found within the fish and shellfish study area are likely to make use of benthic and pelagic habitats for foraging and migratory movement. The fish and shellfish VERs are likely to be vulnerable to changes in/loss of habitat in the short-term but are considered likely to recover rapidly following short to medium term disturbance. Mobile fish and shellfish species are generally considered likely to avoid temporary changes in habitat (EMU, 2004) as they are able to move away from temporary areas of disturbance. Newell *et al.* (1998) found that following cessation of disturbance events, marine communities conform with well-established principles of ecological succession, that communities associated with sandy/coarse gravel sediments are well adapted to rapid recolonization with 'optimistic/pioneering' species establishing initially and later longer-lived and slow-growing organisms.

Estuarine fish assemblage VER

8.11.2.11 Fish species associated with the estuarine fish assemblage VER such as plaice, cod, thornback ray and flounder (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the very short-term when devices/ancillary equipment are deployed. However, recovery is likely to be very high as extensive alternative habitat is available throughout the Waterway and mobile species are likely to move away from any areas of temporary disturbance. Re-colonisation of any habitats that experience temporary changes or disturbance is expected to be rapid as adults and juvenile animals move back into areas temporarily disturbed. Estuarine fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Migratory fish species VER

8.11.2.12 Fish species associated with the migratory fish species VER (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the very short term when devices/ancillary equipment are deployed, however recovery is likely to be rapid as extensive alternative habitat is available throughout the Waterway and the area of potential overlap of the META project with migratory fish species pathways is very small.

8.11.2.13 Warrior Way (site 6) represents the narrowest section for where migratory fish may pass through at circa 330 m from MLWS to MLWS. Dimensions of the device for maximum scenario is 20 m x 10 m, at its longest length the device will occupy 7.57% of the site area within a high energy environment. Migratory fish are likely to avoid high energy environments to conserve energy during the migration and will likely move towards the lee of the meander, away from the site area (Potter, 1988). In addition, migratory fish are likely to react and exhibit avoidance behaviours to the device during installation and use the remaining width of the river to pass by the disturbance. Any disturbance to migratory fish will also be intermittent during the installation phase and temporary in nature. Migratory fish VER has therefore been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Fish spawning or nursery grounds VER

8.11.2.14 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the very short term when devices/ancillary equipment are deployed, however recovery is likely to be rapid as extensive alternative habitat is available throughout the Waterway. East Pickard bay (site 8) and Dale Roads (site 7) lie within sprat spawning grounds and a whiting nursery ground, and Warrior Way (site 6) also lies within/adjacent to a herring spawning ground and a sole nursery ground. These areas may be more vulnerable to disturbance in the long-term, however as outlined above (section 8.11.2.4), potential impacts on these areas are likely to be short-duration and of minimal extent due to limited overlap of the META sites with spawning or nursery areas. It can be expected that there will be no change to the substrate type of the area and therefore will not affect where eggs are laid. Proximity to spawning and nursery grounds can also increase re-colonisation of temporarily disturbed habitats through larval recolonization (Phua *et al.,* 2002). Fish spawning or nursery grounds VER has been deemed to be of medium vulnerability due to the proximity to spawning and/or nursery grounds, high recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be low-medium.

Estuarine shellfish assemblage VER

8.11.2.15 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the very short term when devices/ancillary equipment are deployed, however recovery for mobile species is likely to be very high as extensive alternative shellfish habitat is available throughout the fish and shellfish study area. The most vulnerable species are likely to be demersal, non-mobile species such as native oyster and mussel beds.

8.11.2.16 Any temporary changes in availability of suitable habitat are likely to be temporary with recovery of sediments and associated shellfish communities considered to be rapid. Any changes to sediment disturbance and deposition will be low therefore it is considered unlikely to result in a reduction in abundance of this VER. Shellfish species are therefore considered to be of medium vulnerability to changes in habitat, with a high likelihood of recovery.

8.11.2.17 Estuarine shellfish assemblage VER has therefore been deemed to be of medium vulnerability, high recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

Designated shellfish waters VER

8.11.2.18 The designated shellfish waters VER present within the Waterway (Carew river and the Milford Haven Cleddau (east and western Cleddau rivers)) (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the very short term when devices/ancillary equipment are deployed at Warrior Way (site 6). Waters near Warrior Way (site 6) have been designated for mussels and native oysters which have been found to be highly sensitive to changes in habitat. However, recovery is likely to be very high as any impact will be of very short duration and of limited extent. Designated shellfish waters are considered to be of high vulnerability to changes in habitat associated with deployment of devices at Warrior Way (site 6), with a high likelihood of recovery.

8.11.2.19 Designated shellfish water VER has been deemed to be of high vulnerability, high recoverability and of high value (Table 8.11), there the sensitivity of the receptor is considered to be high.

Shellfish spawning or nursery grounds VER

8.11.2.20 There is a *nephrops* spawning or nursery ground in the wider region, however there is no overlap with the fish and shellfish study area, therefore this VER is unlikely to be impacted by changes in habitat associated with the META project. Shellfish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of the effect

Estuarine fish assemblage VER

8.11.2.21 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.2.22 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.11.2.23 The sensitivity of the receptor is considered to be low-medium and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **negligible - minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.2.24 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Designated shellfish waters VER

8.11.2.25 The sensitivity of the receptor is considered to be high and the magnitude of the impact is deemed to be minor (adverse/beneficial). As the estuarine shellfish assemblage and shellfish spawning or nursery grounds VERs have been assessed as negligible to minor, the effect will, therefore, be of **minor[4] (adverse/beneficial)** significance, which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.2.26 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

8.11.2.27 As no differences in assessment has been noted between META sites, the overall significance of the effect for all sites has been assessed. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.2.28 For all META sites together, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will therefore be of **negligible - minor (adverse/beneficial)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.2.29 No further mitigation is considered necessary.

Temporary increases in suspended sediments

[4] Note: The matrix used for the assessment indicates a minor or moderate significance. Selection of either minor or moderate significance is based on professional judgement.

8.11.2.30 Increases in suspended sediments can lead to adverse effects on fish and shellfish. Temporary increases in suspended sediments may affect sessile organisms (e.g. mussels, oysters) and filter-feeders, potentially damaging feeding and breathing organs. Juvenile fish and shellfish, and eggs may be more susceptible, resulting in increased fatalities, than adult fish and shellfish, as adult species are more able to move away from the source (Wilber, 2001). Increases in suspended sediments may also lead to a reduction in foraging ability due to reduced visibility and olfactory response.

8.11.2.31 The substrate at Warrior Way (site 6) has been described as coarse gravely sand, Dale Roads (site 7) as coarse sand with muddy sediment and at East Pickard Bay (site 8) as poorly sorted coarse sand (chapter 6: Benthic Subtidal and Intertidal Ecology). All three sites therefore have the potential for temporary increases in suspended sediments due to proposed testing activities.

8.11.2.32 Anchoring/attachment of marine energy devices and navigational marker buoys may lead to temporary disturbance of sediment within the test deployment areas. The main activities that will contribute to increases in suspended sediments include the placement of seabed-mounted marine energy devices, drilled pin pilling, placement of gravity anchors or drag anchors for marine energy devices or navigational marker buoys. Vessel movements may also lead to very short-term increases in suspended sediment due to vessel manoeuvring/anchoring or dynamic positioning.

Magnitude of impact

8.11.2.33 All activities proposed at all three test areas are of a temporary and intermittent nature with devices and ancillary equipment such as navigational marker buoys and marine energy devices placed in the marine environment; up to four device deployments in a 12-month period (Warrior Way (site 6)), up to two device deployments in a 12-month period (Dale Roads (site 7)), and up to two device deployments in a 12-month period at each berth therefore up to four device deployments in a 12-month period (East Pickard Bay (site 8)) and under the most likely scenario; up to two device deployments in a 12-month period (Warrior Way (site 6)), up to one device deployments in a 12-month period (Dale Roads (site 7)), and up to one device deployments in a 12-month period (East Pickard Bay (site 8)). Drilled pin pilling may only occur at Dale Roads (site 7) and East Pickard Bay (site 8) and will be of small diameter (100 mm) therefore minimising sediment disturbance.

8.11.2.34 Seabed disturbance and associated temporary increases in suspended sediments due to placement of devices or anchoring is therefore considered to be occasional and of very short duration.

8.11.2.35 Due to the meso-tidal range of Warrior Way (site 6) and Dale Roads (site 7) and the high energy environment at East Pickard Bay (site 8), it can be expected that any suspended sediments will quickly dissipate and disperse according to the sites' hydrological regimes (Chapter 5: Coastal Processes).

8.11.2.36 Chapter 5: Coastal Process has reported sediment types and estimated volume of sediment plume generated by back hoe dredging. Warrior Way (site 6) bed sediment has been characterised by mixed coarse gravely marine sand. Calculated sediment plumes would give rise to approximately 40 mg/l of material which would be expected to settle in a relatively short period of time (one hour) following cessation of works. Dale Roads (site 7) bed sediment has been characterised as coarse sand with muddy sediment with expected sediment plumes of approximately 50 mg/l and expected to settle within two hours of cessation of works. East Pickard Bay (site 8) has been characterised as coarse sand with expected sediment plumes of 70 mg/l which again would be expected to settle following cessation of works after one hour.

8.11.2.37 The potential impact of temporary increases in suspended sediment is therefore predicted to be of local spatial extent, short-term duration, intermittent and reversible for all META sites. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

Estuarine fish assemblage VER

8.11.2.38 Fish species associated with the estuarine fish assemblage VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term when devices/ancillary equipment are deployed, however recovery is likely to be high as all META sites are located in either high energy (East Pickard Bay (site 8)) or meso-tidal energy environments (Warrior Way (site 6) and Dale Roads (site 7)), therefore dispersing any suspended sediments rapidly. Adult fish species will be less vulnerable to impact from suspended sediments as they are highly mobile and are likely to show avoidance behaviour within any areas affected by SCC (Kjelland, 2015). In addition, the META areas occur within areas of already relatively high suspended SSC due to their location within estuaries and associated waters, therefore fish assemblage species are expected to be largely unaffected by temporary low-level increases in SSC. Species are expected to recover as mentioned in section 8.11.2.10. Estuarine fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), there the sensitivity of the receptor is considered to be low.

Migratory fish species VER

8.11.2.39 Fish species associated with the migratory fish species VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term when devices/ancillary equipment are deployed, however recovery is likely to be high as all META sites are located in either high energy (East Pickard Bay (site 8)) or meso-tidal energy environments, therefore dispersing any suspended sediments rapidly. Migratory fish species known to occur in the META project area are also expected to show some tolerance to naturally occurring relatively high levels of SSC in the fish and shellfish study area due to its location within an estuarine environment. Installation activities resulting in temporary increases in SCC are short-lived and likely to result in only short-term changes in migratory fish behaviour (avoidance) and are therefore not considered likely to create a barrier to migratory movement. The migratory fish VER has therefore been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be medium.

Spawning or nursery grounds VER

8.11.2.40 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term when devices/ancillary equipment are deployed. Spawning and nursery grounds may be at higher risk of impact as juvenile fish and eggs are likely to have a higher mortality associated with increases in suspended sediments (section 0) because juvenile fish are more likely to be affected due to decreased mobility and therefore a lower likelihood of avoidance of areas of increased SCC, and eggs may be become smothered by SSC resulting in a decrease of gas diffusion to the egg, leading to cell death. However, any increases in SSC in with the META project area is likely to be minimal (an average of 46.66 mg/l of fine sediment, equivalent to background levels during storm events) and short lived. Similarly, this level of sediment is unlikely to result in a change to the baseline sediments of the area where fish lay their eggs.

8.11.2.41 Warrior Way (site 6) is located within several known spawning areas, and adjacent to a herring spawning site, no drilled piling is to occur at this location and any sediment produced will be as a result of placing structures on the seabed or propeller backwash. Any plumes generated through the placement of structures or from vessel propeller backwash will be quickly dissipated with no change to the baseline substrate. In addition, the suspended sediments in the upper reaches of the Waterway are expected to be transported in an east to west direction down river. Due to the high currents and fluvial sediment input, the area would experience large variations in suspended sediment concentrations, particularly following storm events. Studies undertaken to ascertain background suspended sediment levels prior to dredging campaigns have indicated typical levels of 15 mg/l (Little, 2014) whilst background levels in the approaches to the Waterway have an average annual value 5-10 mg/l (CEFAS, 2016).

8.11.2.42 Spawning or nursery grounds VER has therefore been deemed to be of medium vulnerability, medium recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be medium.

Estuarine shellfish assemblage VER

8.11.2.43 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.10) may be vulnerable to temporary increases in suspended sediment in the very short term when devices/ancillary equipment are deployed, however recovery is likely to be high as all META sites are located in either high energy (East Pickard Bay (site 8)) or meso-tidal energy environments, therefore dispersing any suspended sediments rapidly. Mobile species of shellfish will have access to alternative feeding areas and are likely to avoid any direct impacts from increased suspended sediment. Sessile species of shellfish are potentially more vulnerable to temporary increases in suspended sediment, however all META sites lie out-with areas known to support oyster or mussel beds, therefore the vulnerability of oyster or mussel to impacts from activities associated with the META project are considered low.

8.11.2.44 Many shellfish species are known to be tolerant of suspended sediment (e.g. brown crab), however mobile shellfish species are likely to avoid areas of temporary increased SSC as some species rely on visual acuity during predation (Neal and Wilson, 2008).

8.11.2.45 Estuarine shellfish assemblage VER has therefore been deemed to be of low vulnerability, medium recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be low.

Designated shellfish waters VER

8.11.2.46 The designated shellfish waters VER present within the Waterway (Carew river and the Milford Haven Cleddau (east and western Cleddau rivers)) (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the very short term when devices/ancillary equipment are deployed at Warrior Way (site 6). Waters near Warrior Way (site 6) have been designated for mussels and native oysters which have been found to be highly sensitive to increases in sediment. However, recovery is likely to be very high as any impact will be of very short duration and of limited extent. In addition, there is no overlap of Dale Roads (site 7) or East Pickard Bay (site 8) with bivalve mollusc harvesting areas (Figure 8.5).Designated shellfish waters are considered to be of high vulnerability to changes in habitat associated with deployment of devices at Warrior Way (site 6), with a high likelihood of recovery.

8.11.2.47 Designated shellfish water VER are therefore deemed to be of high vulnerability, high recoverability and of high value (Table 8.11), therefore the sensitivity of the receptor is considered to be high.

Shellfish spawning or nursery grounds VER:

8.11.2.48 There is a *nephrops* spawning or nursery ground in the wider region, however there is minimal overlap with the fish and shellfish study area (north west corner of the fish and shellfish study area at the 12 NM limit), therefore this VER is unlikely to be impacted by increased suspended sediment associated with the META project. Shellfish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of the effect

Estuarine fish assemblage VER

8.11.2.49 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible. The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.2.50 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.11.2.51 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.2.52 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Designated shellfish waters VER

8.11.2.53 The sensitivity of the receptor is considered to be high and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.2.54 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of negligible **(adverse)** significance, which is not significant in EIA terms.

8.11.2.55 As no differences in assessment has been noted between META sites, the overall significance of the effect for all sites has been assessed. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.2.56 For all META sites together, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be negligible. The effect will therefore be of **negligible – minor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.2.57 No further mitigation is considered necessary.

Accidental Pollution

8.11.2.58 During the installation of devices and ancillary infrastructure associated with the device testing at the META project, accidental spillages or release of chemicals, such as fuel, oil and lubricants into the marine environment, could potentially lead to contamination of the marine environment and harm fish and shellfish receptors. It is likely that over time, these pollutants would be dispersed by tidal currents and wave action. Static receptors and less mobile species unable to avoid accidental pollution events are the most likely to be adversely impacted.

Magnitude of impact

8.11.2.59 At this stage, the quantities and types of material that might enter the marine environment at all sites are limited to substances used in vessels, ancillary equipment and marine renewable devices, as well as machines used in close proximity to the water.

8.11.2.60 The magnitude of this impact on fish and shellfish ecology is entirely dependent upon the quantities and nature of the spillage, the dilution and dispersal properties of the waters and the bio-availability of the contaminant to species. The more toxic components of fuel spills are volatile and relatively short-lived. Heavier hydrocarbons, while less toxic, may persist for longer in the marine environment. Pollutants within a low energy environment such as closed harbours, are able to accumulate to potentially toxic levels. All META sites, due to the nature of the marine renewable device, are located within relatively high energy environments. Should any pollutants be accidentally released, dilution and the local hydrodynamic regime will aid in dispersal to levels below that of biological toxicity.

8.11.2.61 Accidents, by definition, are unknown, and with the implementation of an MPCP, the likelihood of a potential effect occurring is considered extremely unlikely.

8.11.2.62 The potential impact of accidental pollution from installation activities is therefore predicted to be of local spatial extent, short term duration, intermittent and reversible. The potential for a pollution event occurring is considered to be unlikely. The magnitude is therefore considered to be negligible (adverse).

Sensitivity of the receptor

Estuarine fish assemblage VER

8.11.2.63 Fish species associated with the estuarine fish assemblage VER (Table 8.10) may be at short-term risk from pollutants accidentally released from the installation of marine renewable devices into the marine environment. Estuarine adult fish species are less likely to be vulnerable to pollutants due to detection and avoidance behaviours and are expected to move away from high concentrations of pollutants. Juvenile fish and eggs are considered more vulnerable to accidental release of pollutants. Estuarine fish assemblage VER is therefore deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be medium.

Migratory fish species VER

8.11.2.64 Fish species associated with the migratory fish species VER (Table 8.10) may be vulnerable to pollutants in the very short-term when the accidental event occurs, however recovery is likely to be high as all META sites are located in either high energy or meso-tidal energy environments, therefore dispersing any pollutants rapidly. This has been demonstrated by the Sea Empress oil spill in 1996 (Edwards and White, 1999). Migratory fish species, such as shad and lamprey, known to occur in the META project area are also expected to show some tolerance and avoidance behaviour to pollutants as evidenced in the Sea Empress spill where no mortalities of these species were recorded following the 72,000 tonnes of light crude oil spilt at the entrance of the Waterway (Edwards and White, 1999), although it is important to point out that this spill occurred in February outside of migrating season. Any accidental pollution event associated with the META project is likely to be significantly smaller in magnitude than occurred as a result of the Sea Empress spill. Installation activities are short-lived and likely to result in only short-term changes in migratory fish behaviour (avoidance) and are therefore not considered likely to result in fish mortality. The migratory fish VER has therefore been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be medium

Spawning or nursery grounds VER

8.11.2.65 Fish, eggs and juvenile fish associated with the spawning or nursery grounds VER (Table 8.10) are the most likely to be affected by accidental pollution. Spawning and nursery grounds may be at higher risk of impact as juvenile fish are likely to have a higher mortality associated with accidental pollution. Juvenile fish and eggs are likely to be affected due to decreased avoidance response and less efficient cellular/compartmentalisation repair mechanisms. Work by Edwards and White (1999) found that a year after the Sea Empress spill in 1996, spawning was poor and juvenile fish were mostly distributed away from the Waterway. However, any accidental spill associated with the META project are likely to be significantly smaller in scale than that associated with the Sea Empress spill, and likely to be dissipated quickly therefore reducing the risk of impacts on any nursery or spawning grounds. The spawning or nursery grounds VER has been deemed to be of medium vulnerability, medium recoverability and of low - high value (Table 8.10), therefore the sensitivity of the receptor is considered to be high.

Estuarine shellfish assemblage VER

8.11.2.66 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.10) may be vulnerable to accidental pollution release in the very short-term when devices/ancillary equipment are deployed, however recovery is likely to be high as all META sites are located in either high energy (East Pickard Bay (site 8)) or meso-tidal energy environments, therefore dispersing any pollutants rapidly. Mobile species of shellfish will have access to alternative feeding areas and are likely to detect and avoid areas of pollution. Sessile species of shellfish are potentially more vulnerable to temporary increases in accidental release of pollutants, however all META sites lie out-with areas known to support oyster or mussel beds, therefore the vulnerability of oyster or mussel to impacts from activities associated with the META project are considered medium.

8.11.2.67 Following the Sea Empress spill, the commercial shellfish market was closed due to potential unsafe shellfish for human consumption in 1996. Following the reopening of the market in 1997, commercial landings were recorded at their highest since records began for shellfish species, indicating growth in population. However, smaller species such as amphipods that are known to be sensitive to pollutants were not recorded on the shores around the spill area (Edwards and White, 1999).

8.11.2.68 Estuarine shellfish assemblage VER has therefore been deemed to be of medium vulnerability, high recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

Designated shellfish waters VER

8.11.2.69 The designated shellfish waters VER present within the Waterway (Carew river and the Waterway Cleddau (east and western Cleddau rivers)) (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the very short-term when devices/ancillary equipment are deployed at Warrior Way (site 6). Waters near Warrior Way (site 6) have been designated for mussels and native oysters which have been found to be highly sensitive to pollution. However, recovery is likely to be very high as any impact will be of very short-term duration and of limited extent. In addition, there is no overlap of Dale Roads (site 7) or East Pickard Bay (site 8) with bivalve mollusc harvesting areas (Figure 8.5), therefore, designated shellfish waters are considered to be of low vulnerability to potential release of pollutants associated with deployment of devices at Warrior Way (site 6), with a high likelihood of recovery

8.11.2.70 Designated shellfish water VER are therefore deemed to be of low vulnerability, high recoverability and of high value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

Shellfish spawning or nursery grounds VER

8.11.2.71 There is a *nephrops* spawning or nursery ground in the wider region, however there is minimal overlap with the fish and shellfish study area (north west corner of the fish and shellfish study area at the 12 NM limit), therefore this VER is unlikely to be impacted by accidental pollution associated with the META project. Shellfish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of effect

Estuarine fish assemblage VER

8.11.2.72 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.2.73 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.11.2.74 The sensitivity of the receptor is considered to be high and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.2.75 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Designated shellfish waters VER

8.11.2.76 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.2.77 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **negligible (adverse)** significance, which is not significant in EIA terms.

8.11.2.78 As no differences in assessment has been noted between META sites, the overall significance of the effect for all sites has been assessed. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.2.79 For all META sites together, the sensitivity of the VERs is considered to be negligible – high, and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **negligible - minor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.2.80 No further mitigation is considered necessary.

Future monitoring

8.11.2.81 No fish and shellfish monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

8.11.3 Operation and maintenance phase

8.11.3.1 The potential environmental impacts arising from the operation and maintenance phase of the META Project are listed in Table 8.12, along with the maximum design scenario against which each potential operation and maintenance phase impact has been assessed. A conclusion of significance of effect has been made for the META project as a whole and for each META phase 2 site individually (Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8)).

Colonisation of hard structures

8.11.3.2 The introduction of a marine renewable device and its associated ancillary infrastructure presents a novel surface for colonisation by fish and shellfish. The marine renewable device is likely to have an EU compliant marine biofoulant that will prevent the colonisation of the structure, however, all supporting/ancillary structures are likely to be made of metal (chains, anchors etc.) and concreate (gravity/mooring bases). Fish could potentially lay eggs on these structures with shellfish actively recruiting and colonising structures.

Magnitude of impact

8.11.3.3 The maximum design area for the installation of a marine renewable device at Warrior Way (site 6) is 375 m^2, a rotor diameter of up to 5 m and a gravity base size of up to 25 m^2. The most likely scenario is a device area of 25 m^2, rotor diameter of 5 m and no gravity base to be deployed. At Dale Roads (site 7) the maximum and most likely scenarios are up to 600 m^2 and 150 m^2 for device area, a 500 m^2 or 75 m^2 for gravity base with a duration of up to 12 months or 6 months, respective. East Pickard Bay (site 8) will have a maximum and most likely scenario of up to 33,810 m^2 and 1,360 m^2 for device area, gravity base up to 1,125 m^2 for both scenarios with a duration of up to 18 months or most likely 6 months. In addition, should a hard structure be reused for another project, the structure will be cleaned of any biota.

8.11.3.4 As stated in section 8.11.3.2, the marine renewable device may have a marine biofoulant applied or be allowed fouling to occur to increase water resistance. However, the most likely structures to be colonised are chains and gravity bases amounting to an area of up to 1,650 m^2 for the maximum scenario.

8.11.3.5 The potential impact of colonisation of hard structures from operation and maintenance activities is therefore predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be negligible (adverse/beneficial).

Sensitivity of the receptor

Estuarine fish assemblage VER

8.11.3.6 Fish species associated with estuarine fish assemblage VER (Table 8.10) are unlikely to be affected by the colonisation of hard structures. However, the structures may indirectly act as a fish aggregation structure and act as beneficial area for hunting, or conversely, for protection from predation, although the size of the structure is unlikely to provide enough refuge to change fish populations (Wilhelmsson, 2014). Therefore, the sensitivity of the receptor is considered to be medium.

Migratory fish species VER

8.11.3.7 Fish species associated with the migratory fish species VER (Table 8.10) are unlikely to be affected by the colonisation of hard structures as migratory fish are known to use man-made structures, such as fishways to transit rivers up to spawning area (Stuart, 2008; Baumgartner, 2010). However, the presence of structures may act as a refuge or as an area to hunt prey that have aggregated there. Therefore, the sensitivity of the receptor is considered to be medium.

Spawning or nursery grounds VER

8.11.3.8 Fish, eggs and juvenile fish associated with the spawning or nursery grounds VER (Table 8.10) are likely to be affected by hard structures as they may lay eggs on the surface as opposed to the environment. Fish known to have a high intensity spawn and nursery ground and are at most risk are cod, sandeel, sole and herring. The first three species do not 'adhere' their eggs onto substrate but broadcast spawn and are therefore not at risk from a structure being removed following an egg laying event. Herring will be spawning near Warrior Way (site 6) and may be affected by removal of hard structures, however, eggs are laid in the million and whilst the structure may be 'coated' in eggs, the removal is unlikely to affect long-term populations. In addition, eggs release by these species number in the millions, should any eggs be adhered to the hard structures, the loss of these eggs is unlikely to affect fish populations. Spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low - high value (Table 8.10), there the sensitivity of the receptor is considered to be negligible.

Estuarine shellfish assemblage VER

8.11.3.9 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.10) are likely to be affected by the presence of a novel hard structure. Mobile shellfish may use the structure for refuge, whilst more sessile shellfish may colonise and recruit to structures that are present during spawning. It is likely that mobile species will colonise/occupy hard structures, provided there is refuge from predation but will move away without injury or mortality upon structure removal. More sessile organisms, such as oysters and mussels have been identified as a medium - high VERs within the Waterway. These sessile species tend to cluster together within identifiable 'beds', of which none are found within any of the META sites. Whilst it is possible for species larvae to settle on these hard structures, as they will be in place over a spawning cycle, it is unlikely for a sufficient number of species to colonise the structure to form a 'bed' as the structures will be removed at the longest deployment after 18 months (East Pickard Bay (site 8). In addition, these species are more likely to be present and form beds on rocky reef habitat as opposed to the sandy sediments found within each site.

8.11.3.10 Estuarine shellfish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Designated shellfish waters VER

8.11.3.11 The designated shellfish waters VER present within the Waterway (Carew river and the Milford Haven Cleddau (east and western Cleddau rivers)) Table 8.11) may colonise the hard structures at Warrior Way (site 6) in the very short term when devices/ancillary equipment are deployed. There is a mussel bed present in close proximity to the site and should a hard structure be present during spawning, there is a possibility for colonisation. However, marine renewable devices to be installed are likely to be marine turbines, where it is unlikely for the rotor itself to be colonised, but the base may be colonised and in addition the maximum scenario will have a 25 m^2 gravity base. Which in the wider context of the area is minute in comparison and will only be in the water for a very short period of time.

8.11.3.12 Designated shellfish water VER are therefore deemed to be of low vulnerability, high recoverability and of high value (Table 8.11, therefore the sensitivity of the receptor is considered to be negligible.

Shellfish spawning or nursery grounds VER:

8.11.3.13 There is a *nephrops* spawning or nursery ground in the wider region, however there is minimal overlap with the fish and shellfish study area (north west corner of the fish and shellfish study area at the 12 NM limit), therefore this VER is unlikely to be impacted by colonisation of hard structures associated with the META project. Shellfish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of effect

Estuarine fish assemblage VER

8.11.3.14 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will therefore be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.3.15 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.11.3.16 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.3.17 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Designated shellfish waters VER

8.11.3.18 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.3.19 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will, therefore, be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

8.11.3.20 As no differences in assessment has been noted between META sites, the overall significance of the effect for all sites has been assessed. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.3.21 For all META sites together, the sensitivity of the VERs is considered to be negligible - medium, and the magnitude of the impact is deemed to be negligible (adverse/beneficial). The effect will therefore be of **negligible (adverse/beneficial)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.3.22 No fish and shellfish monitoring to test the predictions made within the operation and maintenance phase impact assessment is considered necessary.

Medium term habitat loss

8.11.3.23 The presence of marine renewable devices and ancillary infrastructure for the META project with the Waterway may result in a medium term (up to 18 months) habitat loss from the area. It can be expected that impacts are similar to the temporary changes to fish and shellfish at the installation phase. This impact may affect fish and shellfish species both positively and negatively (see section 8.11.2.2 and 8.11.2.3).

Magnitude of impact

8.11.3.24 The combined maximum scenario for all sites for marine renewable devices and ancillary infrastructure for habitat loss is up to 11,050 m^2 and for the most likely scenario is 2,000 m^2. It can be expected that gravity base/moorings are to be in-situ for up to 6 months at Warrior Way (site 6), 12 months for Dale Roads (site 7) and 18 months at East Pickard Bay (site 8).

8.11.3.25 The potential impact of medium-term habitat loss from operation and maintenance activities is therefore predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be minor (adverse).

Sensitivity of the receptor

Estuarine fish assemblage VER

8.11.3.26 Fish species associated with the estuarine fish assemblage VER such as plaice, cod, thornback ray and flounder (Table 8.10) may be vulnerable to medium term habitat loss. It can be expected that impacts are very similar to temporary changes in habitat as described in section 8.11.2.11, and not reiterated here. However, in addition to those impacts described in the installation phase, it can be expected that fish assemblages will habituate to any structures/ habitat loss within the water and most likely will return to site quickly. Estuarine fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Migratory fish species VER

8.11.3.27 Fish species associated with the migratory fish species VER (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the medium term when devices/ancillary equipment are deployed, however recovery is likely to be rapid as extensive alternative habitat is available throughout the Waterway and the area of potential overlap of the META project with migratory fish species pathways is very small. Any disturbance to migratory fish will also be intermittent during the installation phase and temporary in nature. The migratory fish VER has been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Fish spawning or nursery grounds VER

8.11.3.28 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to habitat disturbance or loss of habitat in the medium term when devices/ancillary equipment are deployed. It can be expected that impacts are similar to section 8.11.2.14 and not reiterated here. The fish spawning or nursery grounds VER has been deemed to be of medium vulnerability due to the proximity to spawning and/or nursery grounds, high recoverability and of low - high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low-medium.

Estuarine shellfish assemblage VER

8.11.3.29 Shellfish species associated with the estuarine shellfish assemblage VER (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the medium term when devices/ancillary equipment are deployed, however recovery for mobile species is likely to be very high as extensive alternative shellfish habitat is available throughout the fish and shellfish study area. The most vulnerable species are likely to be demersal, non-mobile species such as native oyster and mussels.

8.11.3.30 Any changes in availability of suitable habitat are likely to be temporary with recovery of sediments and associated shellfish communities considered to be rapid. Any changes to sediment disturbance and deposition will be low therefore it is considered unlikely to result in a reduction in abundance of this VER. All sites are located outside of any mussel and oyster beds and will not directly affect the community. Shellfish species are therefore considered to be of medium vulnerability to changes in habitat, with a high likelihood of recovery.

8.11.3.31 Estuarine shellfish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of low-high value (Table 8.11), therefore the sensitivity of the receptor is considered to be medium.

Designated shellfish waters VER

8.11.3.32 The designated shellfish waters VER present within the Waterway (Carew river and the Milford Haven Cleddau (east and western Cleddau rivers)) (Table 8.11) may be vulnerable to habitat disturbance or loss of habitat in the medium term when devices/ancillary equipment are deployed at Warrior Way (site 6), however recovery is likely to be very high as any impact will be of short duration and of limited extent (maximum 6 months). There is no overlap of Dale Roads (site 7) or East Pickard Bay (site 8) with bivalve mollusc harvesting areas (Figure 8.5). Therefore, designated shellfish waters are considered to be of low vulnerability to changes in habitat associated with deployment of devices at Warrior Way (site 6), with a high likelihood of recovery.

8.11.3.33 The designated shellfish water VER has been deemed to be of low vulnerability, high recoverability and of high value (Table 8.11), therefore the sensitivity of the receptor is considered to be low.

Shellfish spawning or nursery grounds VER

8.11.3.34 There is a *nephrops* spawning or nursery ground in the wider region, however there is no overlap with the fish and shellfish study area, therefore this VER is unlikely to be impacted by changes in habitat associated with the META project. Shellfish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of low value (Table 8.11), therefore the sensitivity of the receptor is considered to be negligible.

Significance of effect

Estuarine fish assemblage VER

8.11.3.35 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.3.36 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

8.11.3.37 The sensitivity of the receptor is considered to be low - medium and the magnitude of the impact is deemed to be minor (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.3.38 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be minor (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Designated shellfish waters VER

8.11.3.39 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.3.40 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be minor (adverse/). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

8.11.3.41 As no differences in assessment has been noted between META sites, the overall significance of the effect for all sites has been assessed. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.3.42 For all META sites together, the sensitivity of the VERs is considered to be negligible – medium, and the magnitude of the impact is deemed to be minor (adverse/beneficial). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.3.43 No fish and shellfish monitoring to test the predictions made within the installation phase impact assessment is considered necessary.

Tidal turbine collision risk at Warrior Way (site 6)

8.11.3.44 Introduction of a marine tidal turbine poses a potential risk to fish receptors at Warrior Way (site 6). It has been assumed for the purpose of this assessment that species of shellfish are not at risk of collision with operational tidal turbines at Warrior Way (site 6), as they are benthic species which are unlikely to utilise areas of the water-column that tidal turbines may be operating within.

8.11.3.45 Key risks to fish receptors from presence of tidal turbines in the marine environment identified by ABPmer (2010) were avoidance by fish and shellfish, and the potential for the presence of tidal turbines to disrupt migration pathways (assessed under impact “Physical barrier to movement of known migratory routes due to presence of tidal devices”.

8.11.3.46 Device components, specifically the terminal end of the rotating blade, poses the greatest risk of potential injury in the event of a collision (Turnpenny *et al.,* 2000). Collision avoidance was associated with visual acuity and maximum swimming speeds of different species, and species-specific near-field behavioural responses in avoiding turbine blades (ABPmer, 2010).

Magnitude of impact

8.11.3.47 The maximum number of tidal turbines to be installed at Warrior Way (site 6) at any time is one. Tidal turbines will be scaled/micro-scale devices. The maximum rotor diameter (maximum scenario) will be up to 5 m, with tip speeds of five m/s or less. This equates to a swept area of 19.63 m^2 (maximum scenario). The most likely scenario is rotor diameter of up to 5 m which equates to a swept area of 19.63 m^2. For context at Warrior Way (site 6), the width of the river from MLWS to MLWS equates to circa. 330 m, this equates to 1.51% (maximum scenario) of the tidal stream cross-sectional area at this location. The maximum duration of scaled tidal device testing at Warrior Way (site 6) is 3-6 months, and the most likely is 1-3 months.

8.11.3.48 Fish species may preferentially utilise the nearshore, or mid-channel areas depending on species and behaviour – e.g. migration or feeding, however data is not available to support these assumptions. It has therefore been assumed that fish species will be evenly spread throughout the water-column and the width of the Waterway within the Warrior Way (site 6) META site. Zhang *et al.,* (2016) found that survival rate of fish in the presence of a tidal turbine with a tip speed of 10 m/s (twice the maximum speed at Warrior Way (site 6)) resulted in 100% survival of all fish species (no injury of deaths) used in the study. In addition, collision risk has been found to be low for small -sized fish, but as the turbines increase in size, greater than 5 m, the risk of collision increases for bigger fish (Hammar, 2015; Wilson, 2006)

8.11.3.49 The magnitude of impact on fish species utilising the water column at Warrior Way (site 6) is therefore predicted to be of local spatial extent, short/medium term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly, however the likelihood of impact is predicted to be negligible. The magnitude is therefore considered to be negligible (adverse).

8.11.3.50 It has also been assumed that benthic species of fish and shellfish have no route to impact with operating tidal turbines due to their bottom-dwelling ecology. The magnitude of impact on benthic fish and shellfish species is therefore considered to be no change and have been scoped out from this impact.

Sensitivity of the receptor

8.11.3.51 Information on sensitivity of fish and shellfish to marine turbines is limited. However, given that scaled or micro-scaled tidal turbines may be operating within the water column at Warrior Way (site 6) and no moving parts will be associated with the seabed, it has been assumed that pelagic species of fish and shellfish, and migratory fish species (e.g. lamprey and eel due to their benthic habit[5]) occurring in the Waterway, have the potential for collision with tidal turbine operating with the Warrior Way (site 6) META site.

Estuarine fish assemblage VER

8.11.3.52 Fish species associated with the estuarine fish assemblage VER (Table 8.10) may be vulnerable to collision with scaled, operational tidal turbines at Warrior Way (site 6). Should an animal come into close proximity to turbine blades or nacelle, it is likely that avoidance behaviour of the perceived risk will minimise potential collision (Zhang *et al.,* 2016; Hammar, 2015). Should a collision occur, recovery is likely (Amaral, 2015).

8.11.3.53 Estuarine fish assemblage VER has therefore been deemed to be of low vulnerability, high recoverability and of medium value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Migratory fish species VER

8.11.3.54 Migratory fish species associated with the migratory fish species VER (Table 8.10) may be vulnerable to collision with scaled, operational tidal turbines at Warrior Way (site 6). Should an animal come into close proximity to turbine blades or nacelle, it is likely that avoidance behaviour of the perceived risk will minimise potential collision (Zhang *et al.,* 2016, Wilson *et al.*, 2006). Should a collision occur, recovery is likely (Amaral, 2015). In addition, migratory species are likely to conserve energy in the lee side of a river, away from high energy environments (Hinch, 2000). As the marine renewable device is designed to generate energy from relatively high energy environments, it is likely any device will be positioned in an unfavourable environment for migratory species (Hinch and Rand, 1998; Hinch, and Rand 2000; Castro-Santos, 2005).

8.11.3.55 Migratory fish VER has therefore been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be medium.

Fish spawning or nursery grounds VER

8.11.3.56 Species associated with the spawning or nursery grounds VER (Table 8.10) may be vulnerable to collision with scaled, operational tidal turbines at Warrior Way (site 6). Should an animal come into close proximity to turbine blades or nacelle, it is likely that avoidance behaviour of the perceived risk will minimise potential collision (Zhang *et al.,* 2016). Should a collision occur, recovery is likely (Amaral, 2015).

8.11.3.57 Fish spawning or nursery grounds VER has therefore been deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Significance of the effect

Estuarine fish assemblage VER

8.11.3.58 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible (adverse). The effect will, therefore, be of **minor (adverse)** significance, which is not significant in EIA terms.

Migratory fish species VER

8.11.3.59 The sensitivity of the receptor is considered to be medium and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Spawning or nursery grounds VER

[5] Lamprey species and European eel primarily migrate along the bottom of river, therefore not impacted by tidal devices.

8.11.3.60 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be **minor (adverse)** significance, which is not significant in EIA terms.

8.11.3.61 This impact has only been assessed for Warrior Way (site 6) as this is the only META project site that will support testing of scaled or micro-scale tidal turbines. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.3.62 The sensitivity of the VERs is considered to be low - medium, and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.3.63

Physical barrier to movement of known migratory routes due to presence of tidal device

8.11.3.64 The presence of a single tidal turbine within the Warrior Way site (site 6) at any time, has the potential to cause a barrier to movement of migratory fish, including displacement from known migratory routes. This could affect migratory species ability to reach breeding / feeding grounds, and therefore may affect breeding success and population viability. Wilson *et al*. (2006) demonstrated that visual appearance and activity of a marine device is important in fish avoidance behaviour. The study found that fish will predominately use vision as their main stimulus and it has been observed that fish do not perform well when ambient light falls below critical levels at night time (Ryer and Olla, 2000). For instance, herring avoided stationary objects using visual stimuli during the day but collided with the same obstacle during the night (Blaxter and Batty, 1985). It has also been found that herring exhibit strong avoidance behaviours of vibrating obstacles in the dark (Blaxter and Batty, 1985).

8.11.3.65 The main species that have been found to migrate through Warrior Way (site 6) are allis shad, twaite shad, river lamprey, sea lamprey, brook lamprey, Atlantic salmon, European eel, and sea trout, however as lamprey species and European eel are known to migrate along the seabed, the main species of concern are Atlantic salmon, trout and shad species.

Magnitude of impact

The maximum number of tidal turbines to be installed at Warrior Way (site 6) at any time is one. Tidal turbines will be scaled/micro-scale devices. The maximum rotor diameter (maximum scenario) will be up to 5 m, with tip speeds of five m/s or less. This equates to a swept area of 19.63 m^2 (maximum scenario). The most likely scenario is rotor diameter of up to 5 m which equates to a swept area of 19.63 m^2. For context at Warrior Way (site 6), the width of the river from MLWS to MLWS equates to circa. 330 m, this equates to 1.51% (maximum scenario) of the tidal stream cross-sectional area at this location. The maximum duration of scaled tidal device testing at Warrior Way (site 6) is 3-6 months, and the most likely is 1-3 months.

8.11.3.66 The potential impact is therefore predicted to be of local spatial extent, short/medium term duration, intermittent and reversible. It is predicted that the impact may affect the receptor directly. The magnitude is therefore, considered to be negligible (adverse).

Sensitivity of the receptor

Estuarine fish assemblage VER

8.11.3.67 Fish species associated with the estuarine fish assemblage VER are considered unlikely to be at potential risk of physical barrier to movement due the presence of an operational tidal turbine at Warrior Way (site 6) as fish are likely to move away or occupy other areas of the Waterway.

8.11.3.68 Estuarine fish assemblage VER are therefore deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Migratory fish species VER

8.11.3.69 The presence of a scaled tidal turbine at Warrior has the potential to pose a barrier to migrating fish species associated with the migratory fish species VER (Table 8.10), however the fish are likely to display some avoidance behaviour in close proximity to an operating turbine. In addition, there is sufficient space for migratory species to pass the turbine and species are likely to migrate along areas of low energy i.e. in the lee of a meander, to conserve energy (Hinch, 2000). Any marine renewable device will most likely be placed in an area of relatively high energy. Any vibration coming from the turbine will most likely be far less than vessels commuting through the area and is unlikely to pose as a barrier to sensitive species such as allis and twaite shad.

8.11.3.70 Migratory fish VER are therefore deemed to be of low vulnerability, high recoverability and of high to very high value (Table 8.10), therefore the sensitivity of the receptor is considered to be low.

Fish spawning or nursery grounds VER

8.11.3.71 Fish species associated with the fish spawning or nursery grounds VER are considered unlikely to be at potential risk of physical barrier to movement due the presence of an operational tidal turbine at Warrior Way (site 6) as they will exhibit avoidance behaviours (Blaxter and Batty, 1985). Any vibration coming from the turbine will most likely be far less than vessels commuting through the area and not pose a barrier to spawning fish, such as herring.

8.11.3.72 Fish spawning or nursery grounds VER has therefore been deemed to be of negligible vulnerability (receptor is not vulnerable to impacts regardless of value/importance).

Estuarine shellfish assemblage VER

8.11.3.73 Species associated with the estuarine shellfish assemblage VER are considered unlikely to be at potential risk of physical barrier to movement due the presence of an operational tidal turbine at Warrior Way (site 6) as shellfish are likely to move away or occupy other areas of the Waterway.

8.11.3.74 Estuarine shellfish assemblage VER has therefore been deemed to be of negligible vulnerability (receptor is not vulnerable to impacts regardless of value/importance).

Designated shellfish waters VER

8.11.3.75 Shellfish species associated with the designated shellfish water VER are considered unlikely to be at potential risk of physical barrier to movement due the presence of an operational tidal turbine at Warrior Way (site 6) as shellfish are likely to move away or occupy other areas of the Waterway.

8.11.3.76 Designated shellfish water VER has therefore been deemed to be of negligible vulnerability (receptor is not vulnerable to impacts regardless of value/importance).

Shellfish spawning or nursery grounds VER

8.11.3.77 Species associated with the shellfish spawning or nursery grounds VER are considered unlikely to be at potential risk of physical barrier to movement due the presence of an operational tidal turbine at Warrior Way (site 6) as shellfish are likely to move away or occupy other areas of the Waterway.

8.11.3.78 Shellfish spawning or nursery grounds VER has therefore been deemed to be of negligible vulnerability (receptor is not vulnerable to impacts regardless of value/importance).

Significance of the effect

Estuarine fish assemblage VER

8.11.3.79 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **minor (adverse) significance** which is not significant in EIA terms.

Migratory fish species VER

8.11.3.80 The sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **minor (adverse)** significance, which is not significant in EIA terms.

Fish spawning or nursery grounds VER

8.11.3.81 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse). There will therefore be no impact on the spawning or nursery grounds VER which is not significant in EIA terms.

Estuarine shellfish assemblage VER

8.11.3.82 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse). There will therefore be no impact on the estuarine shellfish assemblage which is not significant in EIA terms.

Designated shellfish waters VER

8.11.3.83 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse). There will therefore be no impact on designated shellfish waters which is not significant in EIA terms.

Shellfish spawning or nursery grounds VER

8.11.3.84 The sensitivity of the receptor is considered to be negligible and the magnitude of the impact is deemed to be negligible (adverse). There will therefore be no impact on shellfish spawning or nursery grounds which is not significant in EIA terms.

8.11.3.85 This impact has only been assessed for Warrior Way (site 6) as this is the only META project site that will support testing of scaled or micro scaled tidal turbines. In addition, no difference in assessment has been made between maximum and most likely design scenarios, therefore the overall significance of effect for maximum and most likely design scenarios is the same.

8.11.3.86 The sensitivity of the VERs is considered to be negligible – low, and the magnitude of the impact is deemed to be negligible (adverse). The effect will therefore be of **negligible (adverse)** significance, which is not significant in EIA terms.

Further mitigation and residual effect

8.11.3.87 No further mitigation is suggested.

Accidental Pollution

8.11.3.88 Operation and maintenance activities such as device or navigational buoy anchoring, and the presence of marine renewable devices in the water column and sea bed, could have the potential to result in the release of accidental pollutants, resulting in severe adverse biological effects or mortality of fish and shellfish receptors.

8.11.3.89 The magnitude of the impact and sensitivity of receptor is expected to be the same or similar to the effects from installation. Therefore, the significance of effect is therefore negligible or minor adverse significance (see section 8.11.2.58 *et seq.*).

Future monitoring

8.11.3.90 No fish and shellfish monitoring to test the predictions made within the operation and maintenance phase impact assessment is considered necessary.

8.11.4 Decommissioning phase

8.11.4.1 The impacts of the offshore decommissioning of the META project have been assessed on fish and shellfish. The environmental effects arising from the decommissioning of the META project are listed in Table 8.12 along with the maximum and most likely design scenarios against which each decommissioning phase impact has been assessed. The impacts during the decommissioning phase are expected to be of the same nature and magnitude as those predicted from the installation phase therefore the assessment of potential impacts on fish and shellfish presented within section 8.11.2 have been assumed for the decommissioning phase and are not reiterated here.

8.12 Cumulative Impact Assessment methodology

8.12.1 Screening of other projects and plans into the Cumulative Impact Assessment

8.12.1.1 The Cumulative Impact Assessment (CIA) takes into account the impact associated with the META project together with other projects and plans. The projects and plans selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise. Each project has been considered on a case by case basis for scoping in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

8.12.1.2 In undertaking the CIA for the META project, it is important to bear in mind that other projects and plans under consideration will have differing potential for proceeding to an operation and maintenance phase and hence a differing potential to ultimately contribute to a cumulative impact alongside the META project. For example, relevant projects and plans that are already under construction are likely to contribute to cumulative impact with the META project (providing effect or spatial pathways exist), whereas projects and plans not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

8.12.1.3 Table 8.18 presents the projects that have been considered for inclusion in the META project CIA.

Table 8.18: List of other projects and plans considered within the CIA.

Phase	Developer - Reference	Distance from Warrior Way (site 6) (km)	Distance from Dale Roads (site 7) (km)	Distance from East Pickard Bay (site 8) (km)	Spatial/temporal overlap with the META project	Details	Date of Installation/ operation	Further Assessment required?	Taken further for assessment
Plans									
Draft Welsh National Marine Plan (dWNMP) (Welsh Government, 2017)	NRW	0.00	0.0	0.0	Spatial overlap and temporal overlap	The dWNMP is being prepared by the Welsh Government in accordance with the Marine and Coastal Access Act 2009 (MCAA). The purpose of marine planning under the MCAA is to help achieve sustainable development in the marine area. Welsh Ministers are the Marine Planning Authority under the MCAA, responsible for creating marine plans for both the inshore region (0-12 nautical miles) and offshore region (beyond 12 nautical miles) of Wales. Plans for both regions will be presented in a single document, the dWNMP. The dWNMP applies to the Welsh marine area which consists of around 32,000 km^2 of sea, as well as 2,120 km of coastline.	The WNMP will be implemented over a 20-year period, with 3 yearly reviews.	Yes – Benthic Subtidal and Intertidal habitats, Coastal and supralittoral habitats, Marine Mammals, Diadromous fish, Pelagic seabirds (breeding and wintering); and Wildfowl and waders (breeding and wintering).)	As there is the potential for both temporal and spatial overlap of the META project with the dWNMP, it cannot be excluded from further consideration in the CIA. The dWNMP does not need to be considered further for Coastal Processes, Underwater Noise, commercial Fisheries, Shipping and Navigation, Marine Archaeology, Seascape and Landscape, Socio-economic and Tourism and Other Users as the plan does not cover these interests or they have been screened out on the basis that an assessment would be deferred to the project level, or an assessment was not possible at the policy level (Defence, Dredging and disposal, Energy – Oil and Gas, Fisheries, Subsea Cabling, Surface Water and Wastewater Treatment and Disposal, and Tourism and Recreation).
Dredging sites									
Installation/ operation and maintenance	Neyland Yacht Haven ltd. - DML1743	1.1	12.3	10.5	No spatial overlap with consented areas. Potential for temporal overlap.	Dredge and disposal from Neyland Marina - annual volume 5500 m^3.	13/12/2017-12/12/2020	Yes	Sediment plumes generated from dredging activities may present potential cumulative effects with the META project.
Installation/ operation and maintenance	Milford Haven Port Authority - DML1646	1.3	1.5	2.5	No spatial overlap with consented areas Temporal overlap with all sites.	Maintenance dredging throughout the Milford Haven. Annual volume 362500 m^3.	09/03/2017-08/03/2022	Yes	
Dredge disposal sites									
Installation/ operation and maintenance	Neyland dredge disposal site - LU190	0.5	12.4	10.5	No spatial overlap with any of the consented areas. Temporal overlap	Location: South of Neyland within the central channel of the Milford Haven, 0.22 nm diameter x 5 m depth. Status: Open	Not applicable	Yes	Sediment plumes generated from placement of material in identified disposal ground and dredging activities may present potential cumulative effects with the META project.
Installation/ operation and maintenance	Milford Haven Two dredge disposal site - LU169	26.7	20	15	No spatial overlap with any of the consented areas. No temporal overlap.	Location: To the south of Milford Haven dredge disposal grounds, unknown diameter x 50 m depth. Status: Open	Not applicable	No	Dredge disposal site is located at its closest 15 km from the META project, it is therefore highly unlikely to have any impact overlap.
Installation/ operation and maintenance	Milford Haven Three dredge disposal site - LU169	48.9	36	34.7	No spatial overlap with any of the consented areas. No temporal overlap.	Location: To the west of Milford Haven dredge disposal grounds, 1 nm diameter x unknown depth. Status: Open	Not applicable	No	Dredge disposal site is located at its closest 34.7 km from the META project, it is therefore highly unlikely to have any impact overlap.

Phase	Developer - Reference	Distance from Warrior Way (site 6) (km)	Distance from Dale Roads (site 7) (km)	Distance from East Pickard Bay (site 8) (km)	Spatial/temporal overlap with the META project	Details	Date of Installation/ operation	Further Assessment required?	Taken further for assessment
Installation/ operation and maintenance	Milford Haven Two dredge disposal site - LU169	26.7	20	15	No spatial overlap with any of the consented areas. Temporal overlap.	Location: To the south of Milford Haven dredge disposal grounds, unknown diameter x 50 m depth. Status: Open	Not applicable	No	Whilst the site has temporal overlap with the META project, it is unlikely for SSC to cumulatively impact fish and shellfish population.
Installation/ operation and maintenance	Milford Haven Three dredge disposal site - LU169	48.9	36	34.7	No spatial overlap with any of the consented areas. No temporal overlap.	Location: To the west of Milford Haven dredge disposal grounds, 1 nm diameter x unknown depth. Status: Open	Not applicable	No	As above,
Research									
Installation	Greenlink Interconnector Ltd. - RML1827	10.4	6	0	Spatial overlap with East Pickard Bay (site 8). Temporal overlap with East Pickard Bay (site 8).	Ground investigations	07-2018 - no end date given	Yes	Research operations are likely to have vessels present, with equipment for undertaking ground truthing surveys. Increased prop wash may result in further suspended sediments.
Installation	Swansea University - DEML1861	~4-5	~8-9	~6-7	Location is assumed to be by the Pembroke Power station. No spatial overlap with any of the consented areas. Temporal overlap.	Pembroke Power bubble barrier experiment Investigation into the effectiveness of bubble curtains in sediment management	Band 2 licence issued 12/12/2018 - three-year study	No	Due to the nature of the research operations, it is highly unlikely to present overlap with impacts assessed above.
Installation	Swansea University - DEML1845	12.7	5.4	0	Spatial overlap with East Pickard Bay (site 8). Temporal overlap with East Pickard Bay (site 8).	Deposition and subsequent removal of marker buoys with environmental monitoring and mid-water settlement plates.	30/08/2018-29/08/2019	Yes	Vessels and equipment will be required for the placement of marker buoys. It is highly likely to have overlap with impacts.
Infrastructure									
Installation/ operation and maintenance	Neyland Yacht Haven Ltd - CML1658	1.1	12.3	10.5	No spatial overlap with consented areas Temporal overlap with Warrior Way (site 6)	Pile replacement in Neyland Marina.	21/11/2016-20/11/2019	No	Pile replacement is currently ongoing until 2019, which does not overlap with the installation and operation and maintenance phases of the META project. No CEA is therefore required
Installation/ operation and maintenance	Mixed use developments - Local Planning Authority Reference: 14/0158/PA	7.3	5.3	5.6	No spatial overlap with any consented areas. Temporal overlap remains unknown due to insufficient information on start and end dates.	Undetermined planning application. Demolition of several existing buildings and the mixed-use redevelopment of Milford Waterfront comprising up to 26,266 m2 of commercial, hotel, leisure, retail and fishery related floorspace. Up to 190 residential properties, up to 70 additional marina berths, replacement boat yards, landscaping, public realm enhancements, access and	EIA screening decision was returned on the 30/04/2018 - no further information has been provided	Yes	Given the distance from the project and likely impact pathways, there is potential for cumulative impacts to affect fish and shellfish due to increased suspended sediment and/or changes in habitat availability.

Phase	Developer - Reference	Distance from Warrior Way (site 6) (km)	Distance from Dale Roads (site 7) (km)	Distance from East Pickard Bay (site 8) (km)	Spatial/temporal overlap with the META project	Details	Date of Installation/ operation	Further Assessment required?	Taken further for assessment
						ancillary works. A decision on this application is yet to be made by the local planning authority.			
Installation/ operation and maintenance / decommissioning	Greenlink Interconnector Ltd. - Government reference: qA1296053	10.4	6	0	Spatial overlap with East Pickard Bay (site 8). Temporal overlap will occur throughout the duration of the META project	The Project is a 500 MW 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.	07/2018 - ongoing	Yes	There is the potential for cumulative effects on fish and shellfish due to increased suspended sediment and/or changes in habitat availability.
Installation/ operation and maintenance / decommissioning	Valereo - Welsh Government reference: qA1312073	-	-	-	No overlap with the META project as project is assumed to have no marine components.	Development of a cogeneration facility to supplement electrical power and steam demands of the refinery all within the refinery boundaries on land	07/12/2017 - Nationally significant project (ongoing)	No	Project is assumed to have no marine elements to the project, therefore there will be no impact overlap.
Installation/ operation and maintenance / decommissioning	Bombora Wave Energy	11.6	5.0	0	Spatial overlap with East Pickard Bay in intertidal area. Potential for temporal overlap	Bombora on- and off-shore infrastructure and deployment of Bombora mWave device at East Pickard Bay. This is to include device deployment (mWave device), installation of temporary communications cable between mWave device and temporary onshore control station to be located above East Pickard Bay, and installation and operation of temporary control station onshore. Laying of marine cable to shore and through intertidal area at East Pickard Bay to involve up to 3 days cable laying below MHWS using cable lay vessel and up to four vessels, including guard boat. Cable to be laid on seabed and kept in place in sandy sediment by using six, three tonne rock bags covering an area of 4.5 m^2 per rock bag. Where the marine cable traverses potential reefy habitat, it will follow natural rock channel. In the intertidal area, the cable will be laid through a natural gully, or up the vertical gully side and attached to the semi-vertical rock face with rock bolts using hand held tools. JCB will pull the cable through the intertidal area from a location above MHWS.	Q1 2020 - 2022	Yes	Bombora works are likely to cumulatively impact with the META project as spatial overlap is present
Ministry of Defence sites									
Installation/ operation and maintenance / decommissioning	Ministry of Defence	8.1	5.5	0.0	Temporal overlap	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 southern boundary of the East Pickard Bay (Site 8) site is located adjacent to the northern boundary of the Castlemartin Military Practice Area D113A. 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 target. The Castlemartin	N/A	No	There is no impact pathway with this project.

Phase	Developer - Reference	Distance from Warrior Way (site 6) (km)	Distance from Dale Roads (site 7) (km)	Distance from East Pickard Bay (site 8) (km)	Spatial/temporal overlap with the META project	Details	Date of Installation/ operation	Further Assessment required?	Taken further for assessment
						Range is used every day of the week and on some weekends.			
Aquaculture projects									
Installation/ operation and maintenance	Tehthys Oysters	8.9	5.1	2.6	Temporal overlap	The oyster farm is located on the eastern side of Angle Bay, whereby oysters are grown in baskets on metal supports. The farm will be serviced from the shore by foot.	Oct 2017 – Oct 2020 (possible renewal of licence)	Yes	Installation of an oyster farm may result in fish aggregation and as a source recruitment site.
Installation/ operation and maintenance	Pembrokeshire Scallops	15.3	1.8	3.9	Temporal overlap	The scallop farm is located within Castlebeach Bay, whereby a system of weighted ropes will be deployed for growing scallops and mix species of native algae. The farm will be serviced by vessels and divers.	Jan 2019 – Q4 2020 (possible renewal of licence)	Yes	As above.
Pembroke Dock Marine Projects									
Installation/ operation and maintenance	Milford Haven Port Authority - SC1810	2	11.3	8.8	No spatial overlap with consented sites. Potential for temporal overlap.	Pembroke Dock redevelopment Scoping Report submitted. 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.	Oct-18	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 effects with activities associated the META Project.
Installation/ operation and maintenance/ decommissioning	Marine Energy Wales - DEML1875	1.7	11.7	9.4	No spatial overlap with any of the consented areas. Potential for temporal overlap	Marine Energy Test Area - Phase 1 Band 2 application submitted. The Project aims to create pre-consented test areas within the Pembroke Dock area. The test areas will have licensable activities to suit testing of initial stage marine renewable devices. These include testing of non-operating components and subassemblies. No full-scale testing is to be support within the test areas	21/04/2019-21/04/2029	Yes	Vessel use, and some testing activities could result in an increase in suspended sediment or reduction in habitat available to fish and shellfish VERs.
Installation/ operation and maintenance / decommissioning	Wave Hub Ltd. - SC1082	31.4	31.1	25.8	No spatial overlap with any consented areas. Potential for temporal overlap as the projects are linked.	Demonstration zone Scoping Report submitted The Project entails the development of 90 km2 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.	Jul-18	No	This project will not be taken forward in fish and shellfish CEA as no spatial overlap with the META project has been identified.

8.12.1.4 The potential impacts identified for assessment as part of the fish and shellfish cumulative impact assessment (CIA) are:

- Temporary changes in fish and shellfish habitat;
- Temporary increases in suspended sediments;
- Colonisation of hard structures.

8.12.1.5 Impacts 'tidal turbine collision risk', and 'physical barrier to movement of known migratory routes due to presence of tidal device' have not be assessed, as only operations associated with META project testing at Warrior Way (site 6) have the potential to result in either impact.

8.12.1.6 The dWNMP undertook an HRA of the proposed plans included within the dWNMP. The screening exercise for the HRA screened out policies relating to Defence, Dredging and Disposal, Energy – Oil and Gas, Fisheries, Subsea Cabling, Surface Water and Wastewater Treatment and Disposal, and Tourism and Recreation from further consideration in the HRA on the basis that an assessment would be deferred to project level or an assessment was not possible at the policy level. Aggregates, Aquaculture, Energy – Low Carbon (marine renewable energy), and Ports and Shipping were screened in for further assessment. All sites within 50 km (marine buffer area), were considered to be potentially exposed to the effects of the dWNMP.

8.12.1.7 It was concluded within the dWNMP HRA Appropriate Assessment (AA) for screened in policies, that it would be necessary to rely on implementation of general cross-cutting protective policies within the WNMP to safeguard European sites during future assessment of specific schemes/projects. However, it was considered that there would be no adverse effect on site integrity due to the implementation of the policies due to measures that are in place i.e. – the policies are sufficiently caveated and flexible to ensure that adverse effects on site integrity are entirely avoidable at the project-level; the general cross-cutting protective policies within the WMNP will provide safeguards for European sites; evidence from existing schemes suggest that project-level mitigation and avoidance measures are achievable and effective; all projects would require project-level HRA; and Strategic Resource Areas (SRAs) can be modified to reflect best available evidence. For policy on Tidal Lagoons, it was considered that the nature of tidal lagoons means that adverse effects on European sites, particularly habitats, fish and birds, cannot be clearly avoided at the project level, regardless of policy control. However, the AA concludes that there is an over-riding reason of public interest (IROPI) for a Tidal Lagoon policy.

8.13 Cumulative Impact Assessment

8.13.1.1 A description of the significance of cumulative effects upon fish and shellfish receptors arising from each identified impact is given below.

Temporary changes in fish and shellfish habitat

8.13.1.2 Changes in fish and shellfish habitat may occur as a result of cumulative effects arising from projects that spatially or temporally overlap with the META project, as listed in Table 8.18. The potential impacts of changes in fish or shellfish habitat have been outlined in Section 8.11.2.1 and are not re-iterated here.

Magnitude of impact

8.13.1.3 Dredging activities and dredge disposal may result in temporary changes in fish and shellfish habitat in a restricted area around these locations within the Waterway. Research activities are very short duration (days) and of minimal impact on fish and shellfish habitat (temporary deployment of scientific equipment) and are therefore considered unlikely to result in a detectable change on fish and shellfish habitat. Mixed use development of the Milford Haven waterfront, development of the Pembroke Dock infrastructure project, and activities associated with Phase 1 of the META project may result in temporary changes in fish and shellfish habitat in close proximity to Warrior Way (site 6) but is unlikely to affect fish or shellfish habitat at Dale Roads (site 7) or East Pickard Bay (site 8). Cabling works associated with the Greenlink interconnector and proposed Bombora mWave deployment, including the rock bag placement covering a total of 27 m^2, and the mWave deployment itself, may lead to temporary loss of habitat at East Pickard Bay (site 8). The dWMNP concludes no adverse effect on site integrity of any European site due to the plans included within the dWNMP.

8.13.1.4 Though a number of projects are predicted to overlap either with the installation, operation and maintenance, or decommissioning phases of the META project as outlined above, potential changes to fish and shellfish habitat are predicted to be of local spatial extent, temporary in nature, short-medium term duration and are likely to be intermittent and reversible.

8.13.1.5 It is predicted that the impact will affect the receptor directly through loss of habitat, and indirectly through changes in prey availability. The magnitude is therefore considered to be minor.

Sensitivity of receptor

8.13.1.6 Many of the species found within the fish and shellfish study area are likely to make use of benthic habitats for foraging, or the water-column for migratory movement. The fish and shellfish VERs are likely to be vulnerable to changes in/loss of habitat in the short-term but are considered likely to recover rapidly due to availability of alternative foraging and supporting habitat within the Waterway.

8.13.1.7 The META project assessment of sensitivity for fish and shellfish VERs ranged from negligible to medium (section 8.11.2.28), and it is assumed that this is the same for the CIA.

Significance of effect

8.13.1.8 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible - medium. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Temporary increases in suspended sediments

8.13.1.9 The potential impacts of increases in suspended sediment have been outlined in section 0 and are not re-iterated here.

Magnitude of impact

8.13.1.10 Dredging activities and dredge disposal may result in temporary increases in suspended sediment within the Waterway. Research activities are very short duration (days) and are considered to have negligible potential to result in increase in suspended sediment. Mixed use development of the Milford Haven waterfront, development of the Pembroke Dock Infrastructure project, and activities associated with Phase 1 of the META project may result in temporary increases in suspended sediment in close proximity to Warrior Way (site 6) but are unlikely to result in increased suspended sediment at Dale Roads (site 7) or East Pickard Bay (site 8). Cabling works associated with the Greenlink interconnector and the proposed Bomboara mWave deployment may lead to temporary increases of suspended sediment at East Pickard Bay (site 8), but these are expected to be short-duration (days) and temporary in nature.

8.13.1.11 The dWMNP concludes no adverse effect on site integrity of any European site due to the plans included within the dWNMP.

8.13.1.12 Though a number of projects which could lead to increases in suspended sediment within the fish and shellfish study area are predicted to overlap with the installation, operation and maintenance, or decommissioning phases of the META project, potential increases in suspended sediment are not predicted to be extensive or long-term due to the high energy environment and meso-tidal environments present within the Waterway and associated waters. It is considered that increases in suspended sediment could occur in the short-term.

8.13.1.13 The impact is therefore predicted to be of local spatial extent, short- term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be minor.

Sensitivity of receptor

8.13.1.14 The META project assessment of sensitivity for fish and shellfish VERs ranged from negligible to high (section 8.11.2.56), and it is assumed that this is the same for the CIA.

Significance of effect

8.13.1.15 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible – medium. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Colonisation of hard structures

8.13.1.16 The potential impacts of hard structures have been outlined in section 8.11.3.2 *et seq.* and are not re-iterated here.

Magnitude of impact

8.13.1.17 Mixed use development of the Milford Haven waterfront, development of the Pembroke Dock Infrastructure project, the proposed Bombora mWave deployment, including the rock bag placement covering a total of 27 m^2, and activities associated with Phase 1 of the META project may result in an increase in hard structures to the marine environment.

8.13.1.18 Though a number of projects which could lead to increases in hard structures within the fish and shellfish study area are predicted to overlap with the installation, operation and maintenance, or decommissioning phases of the META project, potential increases in hard structures are not predicted to significantly alter the existing fish and shellfish assemblage. Hard structures are present throughout the Waterway and as such any new hard structures are likely to be quickly colonised by existing flora and fauna found within the Waterway. These novel structures may also result in an increase in abundance of existing species resulting in potential beneficial impacts such as the creation of temporary artificial reef habitat or diversification of habitat availability This may result in potential population increases and additional shellfish beds.

8.13.1.19 The dWMNP concludes no adverse effect on site integrity of any European site due to the plans included within the dWNMP.

8.13.1.20 Aquaculture sites at Castlebeach Bay and Angle Bay are designed to grow shellfish and algae for commercial harvesting. These sites may act as a source site for further shellfish recruitment within the Waterway.

8.13.1.21 The impact is therefore predicted to be of local spatial extent, intermittent and over a long-term duration. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be minor.

Sensitivity of receptor

8.13.1.22 The META project assessment of sensitivity for fish and shellfish VERs ranged from negligible - minor (section 8.11.3.6), and it is assumed that this is the same for the CIA.

Significance of effect

8.13.1.23 The magnitude of effect is deemed to be minor, and the sensitivity is deemed to be negligible. The significance of effect is therefore assessed as **negligible – minor (adverse)** which is not significant in EIA terms

Future monitoring

8.13.1.24 No monitoring is proposed to validate the assessment of the CIA.

8.14 Transboundary effects

8.14.1.1 No transboundary impacts are likely to affect the interests of other EEA States, therefore there is no potential for significant transboundary effects with regard to fish and shellfish from the META project.

8.15 Inter-related effects

8.15.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor.

8.15.1.2 Increases in SSC may result in a decrease in visibility and the effectiveness of a fish to see a marine tidal device. This increase in SSC may result in an increased collision risk for fishing passing nearby or through the marine tidal device. However, the impact assessment carried out for fish and shellfish deemed no significant effects on populations. Therefore, it is unlikely for inter-related effects to cause significant impacts to fish and shellfish populations.

8.16 Conclusion and summary

8.16.1.1 Table 8.19 summarises the assessment of effects on fish and shellfish associated with the installation, operation and maintenance, and decommissioning of the META project, alone and cumulatively with other plans or projects.

Table 8.19: Summary of potential environment effects, mitigation and monitoring at the META project.

Description of impact	Measures adopted as part of the project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Installation phase							
Temporary changes to fish and shellfish habitat	n/a	Minor (adverse/beneficial)	Negligible - High	Negligible – Minor (adverse/beneficial) not significant in EIA terms	None	n/a	None
Temporary increases in suspended sediments	n/a	Negligible (adverse)	Negligible - High	Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible (adverse)	Negligible - High	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None
Operation and maintenance phase							
Colonisation of hard structures	n/a	Negligible (adverse/beneficial)	Negligible - Medium	Negligible (adverse/beneficial) not significant in EIA terms	None	n/a	None
Medium term habitat loss	n/a	Minor (adverse)	Negligible - Medium	Minor (adverse) not significant in EIA terms	None	n/a	None
Tidal turbine collision risk at Warrior Way (site 6)	n/a	Negligible (adverse)	Low - Medium	Minor (adverse) not significant in EIA terms	None	n/a	None
Physical barrier to movement/interruption of known migratory routes due to presence of tidal device	n/a	Negligible (adverse)	Negligible - Low	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible (adverse)	Negligible - High	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None
Decommissioning phase							
Temporary changes to fish and shellfish habitat	n/a	Minor (adverse/beneficial)	Negligible - High	Negligible – Minor (adverse/beneficial) not significant in EIA terms	None	n/a	None
Temporary increases in suspended sediments	n/a	Negligible (adverse)	Negligible - High	Minor (adverse) not significant in EIA terms	None	n/a	None
Accidental Pollution	MPCP	Negligible (adverse)	Negligible - High	Negligible – Minor (adverse) not significant in EIA terms	None	n/a	None

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