



MARINE ENERGY WALES

## MARINE ENERGY TEST AREA (META)

Environmental Impact Assessment

Chapter 5:

## Coastal Processes



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Prepared by:

**RPS Energy Ltd.**

Prepared for:

**Marine Energy Wales**

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## Glossary

Term	Definition
Anthropogenic	Originating in human activity
Benthic habitats	Ecological region at lowest level of a water body including sediment surface and some sub-surface layers
Biota	Animal and plant life of a particular region
Estuary	Partly enclosed coastal body of water in which water is mixed with seawater
Fetch	Length of water over which a given wind has blown
Intertidal	Area that is above water during low tide and underwater during high tide
Lagoons	Shallow body of water that is protected from a larger body (usually the ocean) by a sandbar or coral reef
Littoral currents	Current moving approximately parallel to a shore
Meander	One of a series of bends in the channel of a river, stream or watercourse
Meso-tidal range	Tidal range of 2-4m
Metoccean regime	Abbreviation of meteorology and oceanography
Morphology	Study of the origin and development of coastal features
Neap tides	Tide following the first and third quarters of the moon during which the tidal range is minimum
Peninsula	Landform with water on the majority of its border while being connected to the mainland from which it extends
Rip tide	Strong, localised and narrow current of water which moves directly away from the shore
SEACAMS	The SEACAMS project is a partnership between Bangor University and Swansea University, part-funded by the European Regional Development Fund. It supports developing economic opportunities in Low Carbon, Energy and Environment through specialisation in commercial application of research and innovation in marine renewable energy
Sea caves	Cave formed primarily by the wave action of the sea
Sediment transport	Movement of solid particles (sediment) due to gravitational forces and/or the movement of the fluid in which the sediment is entrained
Semi-diurnal tide	Two high and two low tides per day
Significant wave height	Mean wave height of the highest one third of the waves
Spring tides	Tide following a new or full moon during which the tidal range is maximum
Storm surge	Similar to swell wave - rising of water level commonly associated with low pressure weather systems
Subtidal	Area that is below water during low tide
Suspended sediment	Solid particles uplifted by the fluid's flow
Swell wave	Surface waves generated by the pressure in distant weather systems
Tidal excursion	The horizontal distance along the estuary that a particle moves during one tidal cycle of ebb and flood
Tidal flow (or current)	Currents resulting from the impact on sea level caused by the interaction of the Earth, sun and moon
Tidal range	Height difference between high tide and low tide
Transboundary	Moving or having impact across a boundary or boundaries
Wind wave	Surface waves generated from wind blowing over an area of fluid surface

## Acronyms

Term	Definition
ABPmer	Marine Consultancy; subsidiary of Associated British Ports Holdings Ltd
ADCP	Acoustic Doppler Current Profiler
BERR	(Department for) Business, Enterprise and Regulatory Reform
CD	Chart Datum
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFD	Computational Fluid Dynamics
CHP	Combined Heat and Power
CIA	Cumulative Impact Assessment
CIRIA	Construction Industry Research and Information Association
cSAC	Candidate Special Area of Conservation
DECC	Department of Energy & Climate Change
EEA	European Economic Area
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ES	Environmental Statement
ICE	Institution of Civil Engineers
LNG	Liquefied Natural Gas
MCT	Marine Current Turbines
MEECE	Marine Energy Engineering Centre of Excellence
META	Marine Energy Test area
MHWESG	Milford Haven Waterway Environmental Surveillance Group
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
MOD	Ministry of Defence
NPS	National Policy Statement
NRW	Natural Resources Wales
PCC	Pembrokeshire County Council
PCNPA	Pembrokeshire Coast National Park
SAC	Special Area of Conservation
SPA	Special Protection Area
SSC	Suspended sediment concentration
SSSI	Site of Special Scientific Interest
WEC	Wave Energy Converter
Zol	Zone of Impact

## Units

Term	Definition
%	percent
Ha	hectares
hour	hour
kg/m <sup>3</sup>	kilograms per cubic metre
km	kilometre
kW/m	kilowatts per metre
m	metres
m/s	metres per second
m <sup>2</sup>	metres squared
m <sup>3</sup>	metres cubed
mg/l	milligrams per litre
mm	millimetres
MW	megawatts
nm	nanometre
NM	nautical mile
T	tonnes

## 5. COASTAL PROCESSES

### 5.1 Introduction

#### 5.1.1 Introduction

5.1.1.1 This chapter of the Environmental Statement presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of the META project on Coastal Processes. This chapter considers the potential impact of the off-shore component of META project during its installation, operation and maintenance, and decommissioning phases.

5.1.1.2 The coastal processes assessment is undertaken to inform the consideration of potential impacts on coastal processes receptors. In addition, predictions of changes to coastal process are provided to inform a range of other receptors that are assessed in other chapters of this Environmental Statement (chapter 7: Benthic Subtidal and Intertidal Ecology, chapter 12: Shipping and Navigation; chapter 15: Socio-economic and Tourism; and chapter 16: Other Users). For those effects where the receptor lies within the coastal processes topic, a full impact assessment is provided here. For those effects where the receptor is assessed in another chapter of this Environmental Statement, the magnitude of change only is considered in this assessment.

#### 5.1.2 Purpose of this chapter

5.1.2.1 The primary purpose of the Environmental Statement is to support the marine consents and licences for the META project, which are outlined in chapter 1: Introduction.

5.1.2.2 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.

5.1.2.3 In particular, this Environmental Statement chapter:

- Presents the existing environmental baseline established from desk studies;
- Presents the potential environmental effects on coastal processes arising from the META project, based on the information gathered and the analysis and assessments undertaken;
- Identifies any assumptions and limitations encountered in compiling the environmental information; and
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

### 5.2 Study area

5.2.1.1 The generalised coastal processes study area for the META project is termed as the coastal processes study area – defined as the area inclusive of the Waterway and extends up to the 12 NM limit, from St Govan’s Head to Skomer Island (see Figure 5.1). This area encompasses the region over which the environmental designations are specified. The area is also of a magnitude which reflects the scale of the coastal process drivers such as tidal flow, swell wave and local wind wave generation.

5.2.1.2 The META sites that will support activities that necessitate a requirement for EIA are:

- Warrior Way (site 6);
- Dale Roads (site 7); and
- East Pickard Bay (site 8).

5.2.1.3 At each site the coastal features and environment varies which makes the locations suitable to different types of testing activities and subject to different potential impacts. Therefore, the more detailed assessments on coastal processes are undertaken on sub-areas of the coastal processes study area. A description of the META project sites assessed in the EIA is provided below.

#### *Warrior Way (site 6)*

5.2.1.4 Warrior Way is located within the Waterway offshore from the Pembrokeshire Science and Technology Park, south east of Pembroke Ferry, and at the mouth of the Cosheston Pill. The site supports the greatest tidal resource in the Milford Haven Estuary (1.2 m/s) and has a depth of between 16-19 m. The Warrior Way site encompasses an area of 93,000 m<sup>2</sup> (9.3 Ha) and lies entirely within the Pembrokeshire Marine / Sir Benfro Forol Special Area of Conservation (SAC), in close proximity to habitats identified as “Nationally Important Intertidal Habitats”, and immediately adjacent to the Waterway Site of Special Scientific Interest (SSSI) designated for a variety of natural features including, estuaries; marine habitats; species of wildfowl and waders; and European otter (*Lutra lutra*) (JNCC (2016)). Figure 5.2 illustrates the location and extent of Warrior Way (including indicative footprint of infrastructure) in relation to the surrounding Waterway and environmental designated sites.

### ***Dale Roads (site 7)***

- 5.2.1.5 Dale Roads (site 7) lies outside the Dale shelf anchorage within the Waterway to the west of Great Castle Head, and south of St Ishmael's. It supports depths of between 8 and 12 m and benefits from a significant wind and wave fetch from the south and southwest. The site encompasses an area of 195,565 m<sup>2</sup> (19.56 Ha) and lies entirely within the Pembrokeshire Marine/ Sir Benfro Forol SAC designated for grey seal (*Halichoerus grypus*), marine habitats, coastal lagoons, submerged or partially submerged sea caves, otter and species of migratory fish, and the West Wales Marine candidate SAC (cSAC) proposed for harbour porpoise (*Phocoena phocoena*). The coast at Dale Roads is part of the Waterway SSSI designated for a variety of natural features including, estuaries, marine habitats, species of wildfowl and waders, and otter.
- 5.2.1.6 Figure 5.3 illustrates the location and extent of Dale Roads (site 7) (including indicative footprint of infrastructure) in relation to the surrounding Waterway and environmental designated sites.

### ***East Pickard Bay (site 8)***

- 5.2.1.7 The north-west side of East Pickard Bay (site 8) overlaps with the southern boundary of the Waterway. It lies immediately south of Sheep Island and runs south-eastward parallel to the coast towards Freshwater West Bay.
- 5.2.1.8 The META project offshore site is exposed to a good wave resource benefiting from a 200 km fetch from the prevailing wind direction and has a water depth of between 10 and 29 m. The East Pickard Bay site (site 8) encompasses an area of 1,230,000 m<sup>2</sup> (123 Ha) and lies entirely within the Pembrokeshire Marine/ Sir Benfro Forol SAC designated for grey seal, marine habitats, coastal lagoons, submerged or partially submerged sea caves, otter and species of migratory fish, and the West Wales Marine cSAC proposed for harbour porpoise. The Castlemartin Coast Special Protection Area (SPA) lies inland to the north east of the East Pickard Bay site.
- 5.2.1.9 Figure 5.4 illustrates the location and extent of East Pickard Bay (site 8) (including indicative footprint of infrastructure) in relation to the surrounding Waterway and environmental designated sites. The site also lies adjacent to a Ministry of Defence (MOD) Danger Area.

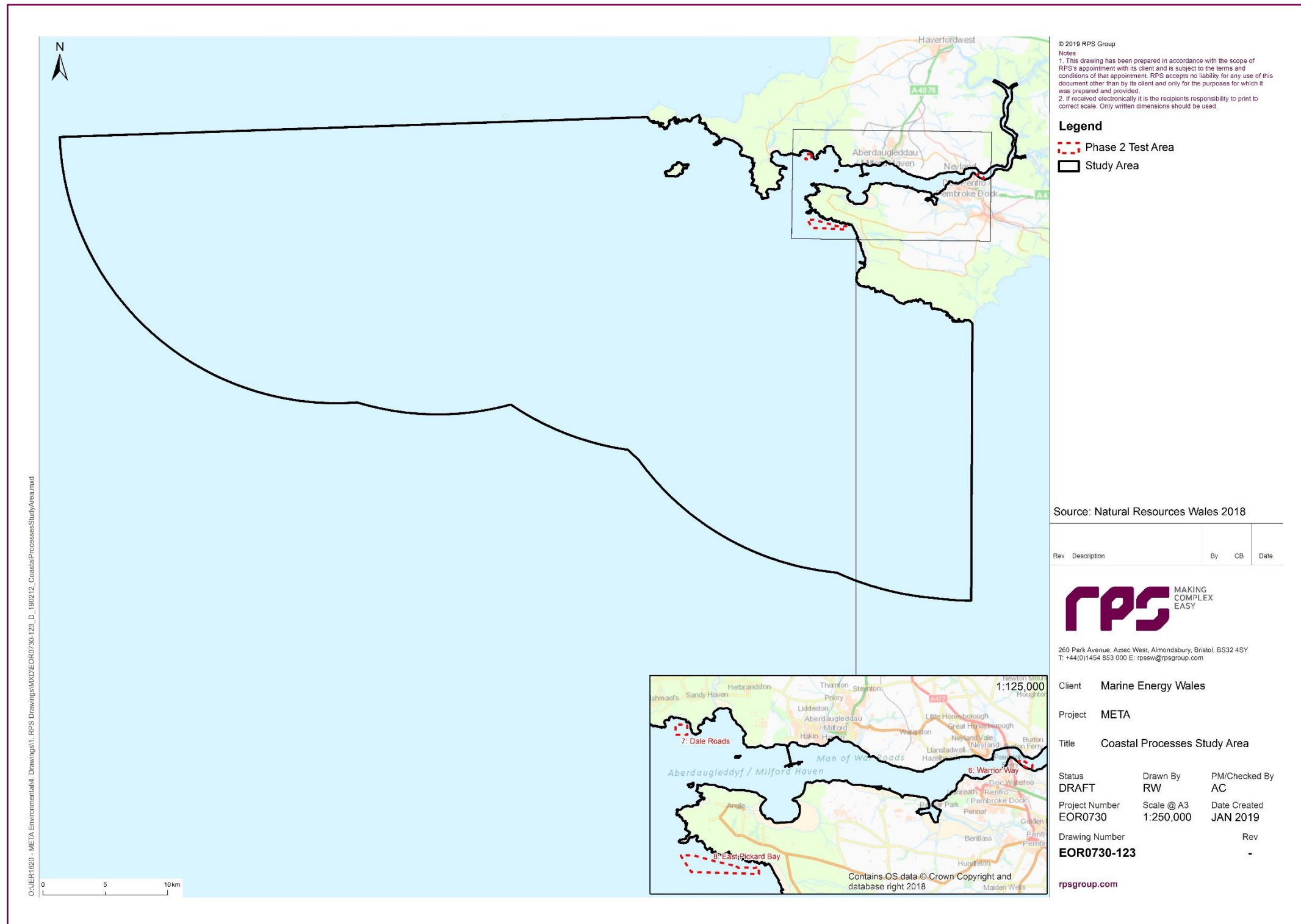


Figure 5.1 The META project coastal processes study area.

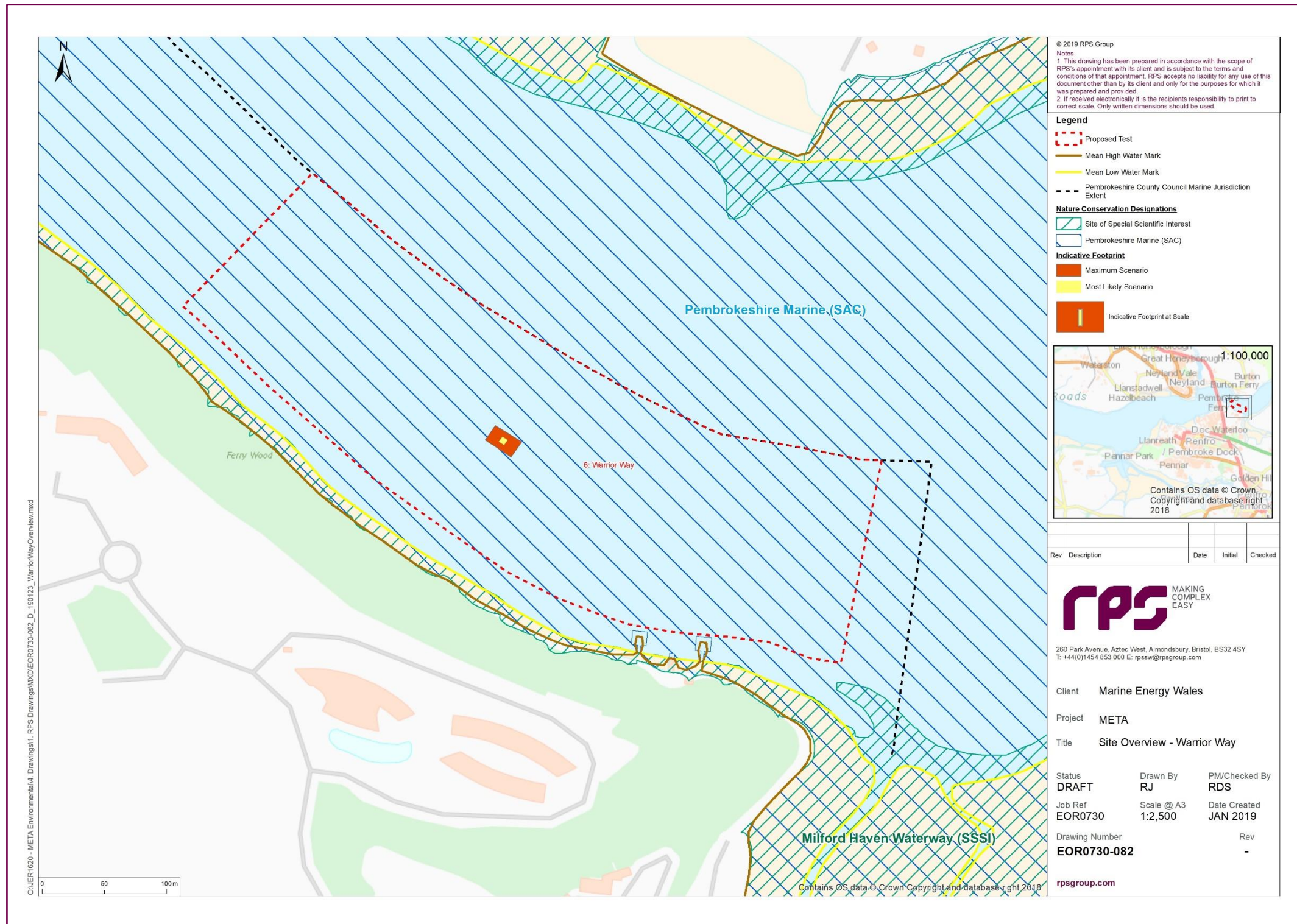


Figure 5.2: Location of Warrior Way (site 6).

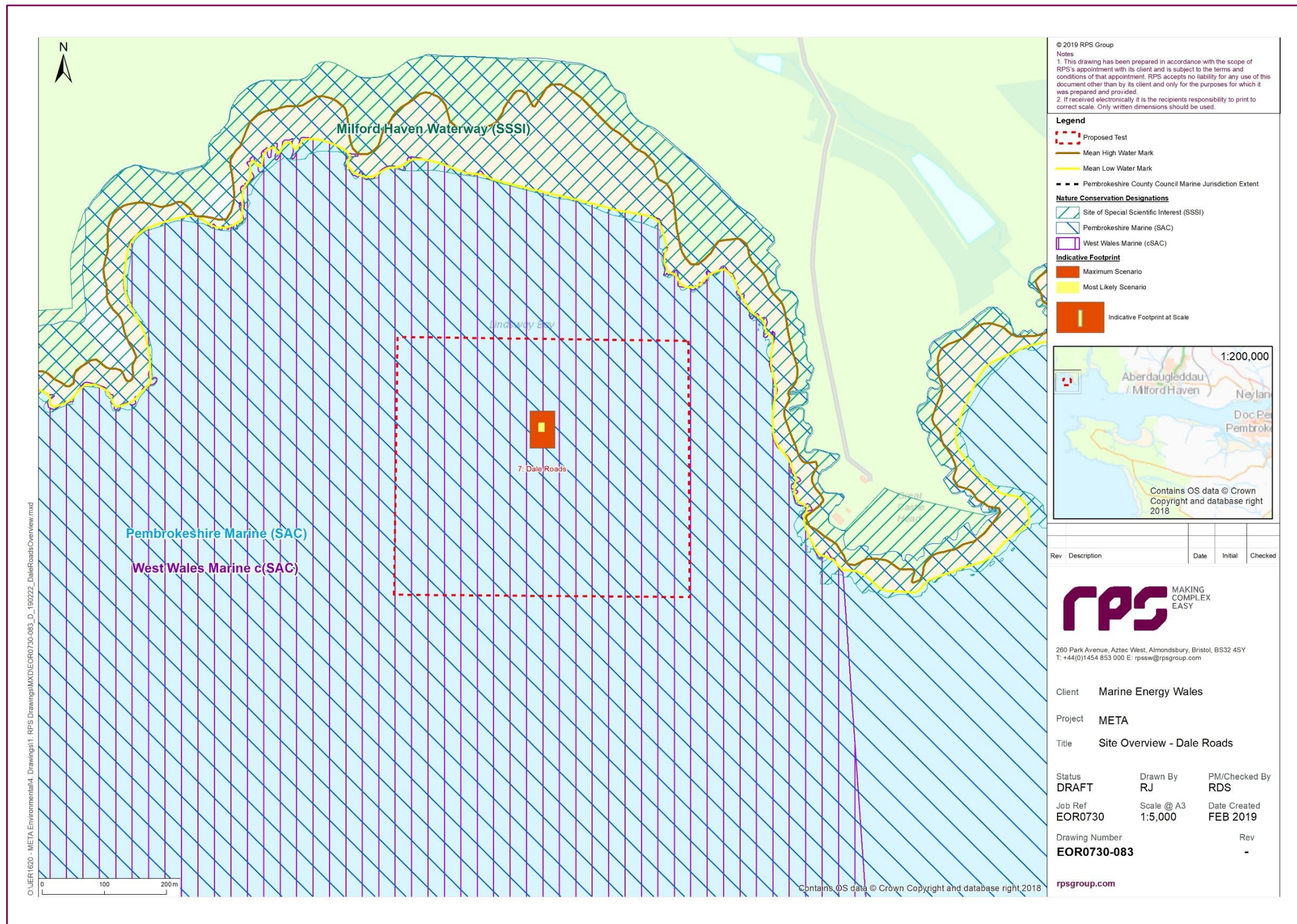


Figure 5.3: Location of Dale Roads (site 7).

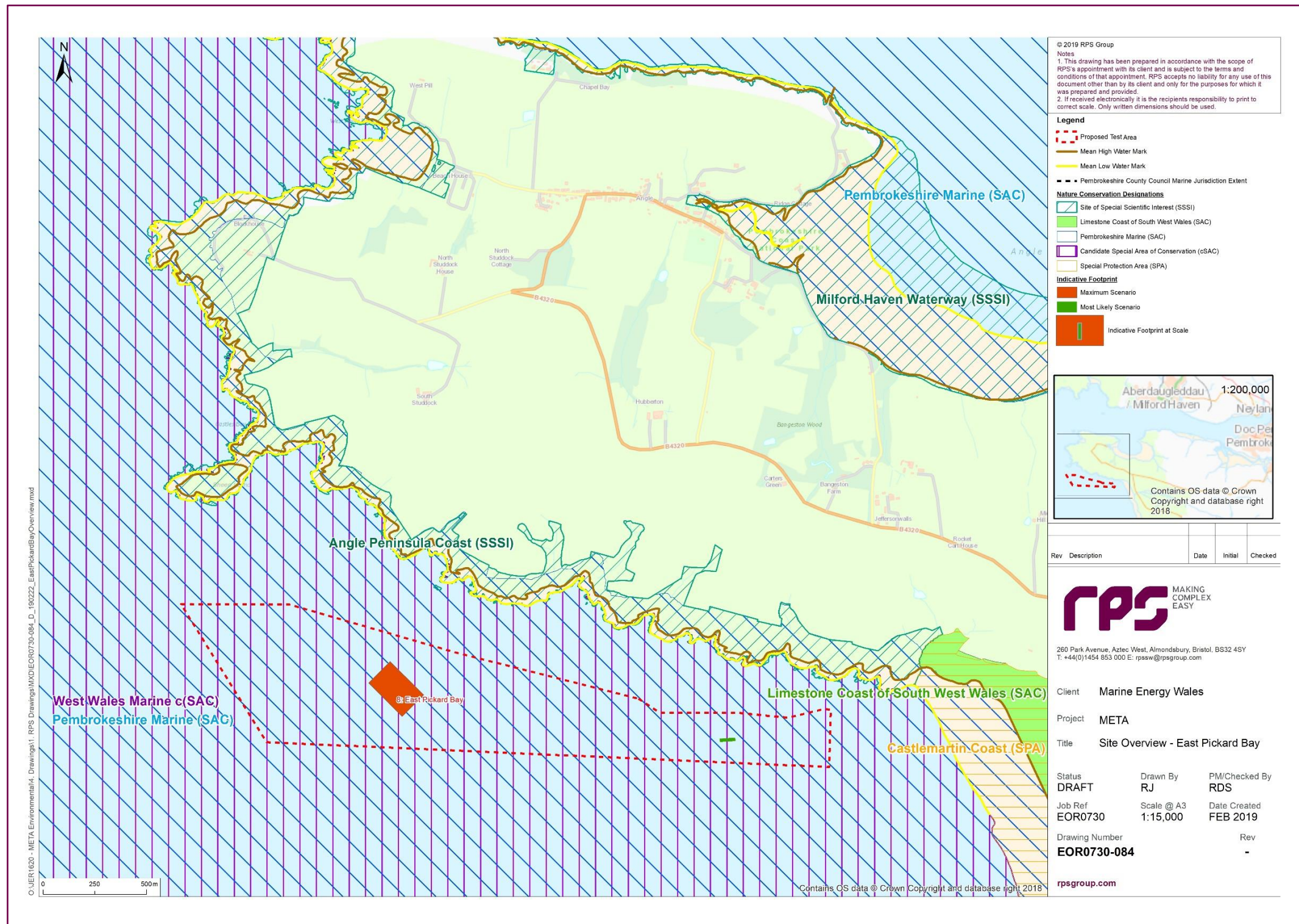


Figure 5.4: Location of East Pickard Bay (site 8).

## 5.3 Policy context

5.3.1.1 A summary of national legislation and consenting policy context in Wales relevant to the consenting of the META project, is provided in chapter 3: Need and Alternatives, with details provided in Appendix 3.1.

### 5.3.2 National Policy Statements

5.3.2.1 Planning policy on renewable energy infrastructure 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). NPS EN-1 and NPS EN-3 include guidance on what matters are to be considered in the assessment of coastal processes, whether these be through direct effects on the physical environment or indirect effects. Changes to coastal process have been considered within this chapter and the indirect effects of these changes have been considered in other relevant chapters of this Environmental Statement.

## 5.4 Consultation

5.4.1.1 Table 5.1 below summarises the issues raised relevant to coastal processes, which have been identified during consultation activities undertaken to date. Table 5.1 also indicates either how these issues have been addressed within this Environmental Statement or how the Applicant has had regard to them.

**Table 5.1: Summary of key issues raised during consultation activities undertaken for the META project relevant to coastal processes.**

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
January 2019	Bombora Wavepower e-mail correspondence	Request made to potential user of META for additional monitoring data and confirmation of device efficiency	Data received was applied in assessment in East Pickard Bay (site 8) section 5.9.2
January 2019	NRW-Advisory	Survey requirements at META sites.	On the basis of NRW's advice, the boundary of the Warrior Way (site 6) East Pickard Bay test area (site 8) has been revised to avoid the designated reef feature at this location. The East Pickard Bay test area (site 8) therefore only covers the sand substrate at this location.
01 March 2019	NRW	Table 6-1: 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.	This has been assessed in section 5.9.
28 March 2019	NRW – Scoping Opinion	Section 6.1.5: Proposed approach to EIA it is stated in Paragraph 2 that: “Due to the	Beach response modelling is proposed as not required. As per the NRW

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
		relatively small scale of the devices and the temporary and short-term nature of the deployments at META it is anticipated that morphological beach response modelling will be required to support the EIA”. We presume that this is supposed to read will not be required, and we are satisfied that beach response modelling will not be required.	Scoping Opinion, this has not been undertaken for the META project.

## 5.5 Methodology to inform the baseline

### 5.5.1 Desktop study

5.5.1.1 Information on Coastal Processes within the coastal processes study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 5.2 below.

**Table 5.2: Summary of key desktop reports.**

Title	Source	Year	Author
Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects	Natural Resources Wales (NRW)	2018	Brooks <i>et al</i> , 2018
Wave & Flow Modelling: Conditions for Wave Energy Converter Deployment	Bombora Wave Energy	2018	ABPmer Ltd <i>et al</i> .
Estimates of wave climate at potential wave energy test sites around Milford Haven	SEACAMS2	2018	Yin, Y.; Fairly I. & Reeve D.
Suspended Sediment Climatologies around the UK	CEFAS	2016	CEFAS
Milford Haven Sediment hydrocarbon & Metals contamination	Milford Haven Waterway Environmental Surveillance Group	2014	Little, D.I. & Galperin, Y
Sediment-profile imaging survey of Milford Haven Waterway	Milford Haven Waterway Environmental Surveillance Group	2012	Germano & Assoc. Ltd
Lavernock Point to St Ann's Head Shoreline Management Plan		2012	Halcrow
Wave resources in South Wales & a comparison with wave climate at the wave hub	Marine Energy Research Group, Swansea University	2012	Fairley, I.
Tidal Energy Resource Study for the Copeland Islands	ICE Innovative Coastal Zone Management	2011	Shannon N.R. & Laurent D.

Title	Source	Year	Author
Sediment Contaminants and Transport Review	Milford Haven Waterway Environmental Surveillance Group	2009	Little, D.I.
Guidelines in the use of metocean data through the lifecycle of a marine renewables development	CIRIA	2008	ABPmer Ltd <i>et al.</i>
Review of Cabling Techniques and Environmental Effects applicable to the Offshore Wind Farm Industry	BERR	2008	BERR
Dynamics of scour pits and scour protection - Synthesis report and recommendations	DECC	2008	Whitehouse, R.; Harris, J.; Rees, J.
Atlas of Marine Renewable Energy Resources	BERR	2008	BERR
Strangford Lough Marine Current Turbine Environmental Statement	Marine Current Turbines (MCT)	2005	Marine Current Turbines / Royal Haskoning
Potential effects of offshore wind developments on coastal processes		2002	Beiboer and Cooper
Metal concentrations in Milford Haven seabed sediments	Milford Haven Waterway Environmental Steering Group	1994	Smith, J & Hobbs, G.

5.5.1.2 In addition to reports, both numerical model data and measured field data were used to quantify baseline characteristics on tidal currents and wave climates. These principally included the following:

- Bathymetric survey information to support historic applications for maintenance dredging operations within the Waterway;
- Relevant coastal processes information and model output from other developments in Milford Haven including South Hook LNG terminal and CHP station, Pembroke Power Station (studies undertaken by RPS); and
- Bathymetric and ADCP data from Pickard Bay provided by Bombora Wavepower.

5.5.1.3 It should be noted that while consideration has been taken of the NRW Report No. 243 (Brooks *et al*, 2018), this guidance relates to major construction project such as large arrays of tidal stream converters or wave energy devices, deployed on large piles or supported by large cession-like structures, and associated cables buried into the seabed or protected by rock-dumping. As the META project does not propose any of the above, the guidance has been reviewed, it is relevant but not directly applicable to the META project.

### Identification of designated sites

5.5.1.4 All designated sites within the coastal processes 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 for each discipline:

- Step 1: All designated sites of international, national and local importance within the coastal processes study area were identified.
- Step 2: Information was compiled on the relevant features for each of these sites.
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - e.g. a designated site directly overlaps with the META project; and
  - e.g. sites and associated features were located within the potential Zone of Impact (ZoI) for impacts associated with the META project.

5.5.1.5 The coastal processes assessment was then defined to provide information on each of these areas for each discipline. All sites supporting Phase 2 activities are present within the Pembrokeshire Marine/ Sir Benfro Forol SAC (a Natura 2000 site) and as such are protected under the Habitats Directive (1992). Therefore, the coastal processes were examined for each site and activity to provide information for each EIA discipline.

## 5.5.2 Site specific surveys

5.5.2.1 No site-specific surveys have been undertaken to inform the EIA for Coastal Processes. This is because sufficient data was available from the desktop data sources outlined in Table 5.2 which included field and modelled data (Table 5.2).

## 5.6 Baseline environment

### 5.6.1 Study area

5.6.1.1 The Warrior Way (site 6) and Dale Roads (site 7) sites are both located within the coastal processes study area. The Waterway is a deep-water macro-tidal ria believed to be created by the flooding of the Daugleddau river valley (which itself was formed by the merging of the tributaries of the Eastern and Western Cleddau), during the sea level rise at the end of the last Ice Age (Halcrow, 2012). It is the largest flooded valley in Europe and is also a historical deep-water anchorage. The Waterway has the capacity to be a large sediment sink, based on its morphology, however there is limited sediment input from offshore areas and the rivers flowing into the Waterway are not thought to contribute large volumes of sediment (Halcrow, 2012). Within the catchment are the two main rivers of the Western and Eastern Cleddau, which merge to form the Daugleddau before entering the Waterway. Pembroke River also flows into to the Waterway just west of Pembroke Dock.

- 5.6.1.2 Hobbs and Morgan (1992) describe the geomorphological processes that have resulted in the unusually high proportion of hard substrates within the Waterway, flanked by areas in which there are substantial thicknesses of mud. These areas of mud were derived from the rivers and have accumulated primarily in sheltered mudflats. Sediment transport along the frontage of the south shore of the Waterway is generally from west to east and tends to be finer sediments due to the generally low tidal currents in the estuary. A coordinated surveillance programme for Waterway has been undertaken for more than 20 years by the MHW Environmental Surveillance Group (MHWESG). The most comprehensive assessment was undertaken in 2012 when a detailed map and dataset was derived of the sedimentary habitats in the Waterway (Germano & Assoc. Ltd, 2012). Sediment profiling of the seafloor surface was undertaken at over 500 locations providing information for the META project assessment.
- 5.6.1.3 The high tidal range within the Waterway means that water movements in the estuary are extensive. The tidal excursion (the horizontal distance along the estuary that a particle moves during one tidal cycle of ebb and flood) varies along the length of the estuary and is approximately twice as great for spring tides as for neap tides. SCC levels are commonly elevated within the Waterway with recorded levels varying greatly between tidal state and location. Extensive sampling reported by MHWESG (Little 2009) shows samples in excess of 100mg/l. More commonly background levels within the Waterway are 16mg/l increasing to 84mg/l upstream where fluvial sediment sources enter the Waterway. Strong south-westerly winds, the prevailing wind direction for the Haven, can cause noticeable variations in the heights of the tide.
- 5.6.1.4 Due to the prevailing offshore wave climate, where in excess of 90% of the waves approach from the south or south west sectors, there is wave penetration into the Waterway. Due to the geometry and alignment of the Waterway two distinct regions are formed. Those areas to the west of the Angle promontory, including the Dale Roads site (site 7), are strongly influenced by wave climate. Whilst to the east of the promontory, including the Warrior Way site (site 6), are tidally dominated as the tidal range is large and wave penetration is limited. Calibrated numerical models developed by RPS for previous environmental studies were used to inform this EIA by providing tidal flows and current speeds in Milford Haven. The characteristics of the two distinctly different sites are discussed separately, as follows.

#### Warrior Way (site 6)

- 5.6.1.5 Warrior Way (site 6) is situated entirely within the Pembrokeshire Marine/Sir Benfro Forol SAC, east of the Cleddau bridge, in a semi-diurnal tidal setting with a meso-tidal range. The tidal range propagates from the mouth of the Waterway up into the estuary, with high tide moving in a west to easterly direction. This stretch of the estuary supports the greatest tidal resource in the Milford Haven Estuary (1.2 m/s) and has a depth of between 16-19 metres chart datum<sup>1</sup> (CD). Currents are predominately flowing in an east to westerly direction as a result of the river flow from the eastern and western Cleddau rivers that form a confluence and flow into Daugleddau river, constituting the Waterway.

<sup>1</sup> The level below which depths are indicated and above which heights of the tides are expressed; usually mean level of low water at a spring tide.

- 5.6.1.6 Warrior Way (site 6) experiences a large tidal range of in excess of 8 m during spring tides which give rise to peak tidal currents of 1.2m/s however it should be noted that during neap tides the tidal excursion is typically half that of spring range resulting in peak currents of 0.5 m/s. The site itself is located on the southern side of the channel and occupies approximately 50% of the width. A large variation in water depth is experienced at the site with up to a 50% difference as a result of tides alone. Typically, current speed on the flood tide is 10% greater than that of the ebb tide, where flow is directed into deeper areas in the north of the channel.
- 5.6.1.7 Predominantly grey-green very fine to coarse-grained, plant-bearing sandstones, and red-brown and purple-brown siltstones make up the bedrock of the Warrior Way site (site 6). It is protected from high energy wave forces due to its location further up the estuary compared to Dale Roads (site 7) and East Pickard Bay (site 8) which are present at the mouth of the estuary. However, Warrior Way (site 6) is present on the outside of a meander, down river and at the mouth of Coshaston Pill entrance of the Daugleddau Estuary. At this location, sediment was found to be very coarse-grained sand and gravel, with a large range of 1 - 64 mm, (Germano & Assoc. Ltd, 2012) and dependent on fluvial deposits from the river and hydrodynamic processes (increase in flow would result in less fine sediments being present at site). The Fluvial sediment source is expected to be transported in an east to west direction down river. Due to the high currents and fluvial sediment input this area would experience large variations in suspended sediment concentrations, particularly following storm events.
- 5.6.1.8 Chapter 7: Benthic Subtidal and Intertidal Ecology, section 7.7.2.10 describes the sediment types and sizes predicted at Warrior Way (site 6). EUSeaMap (2016) data predict low energy infralittoral seabed sediments coinciding with Warrior Way (site 6). SPI survey data identify Warrior Way (site 6) as "*Channel Mixed Physical*" with a surface grain size of very coarse sand (Germano and Associates, 2013).

### Dale Roads (site 7)

- 5.6.1.9 Dale Roads (site 7) is situated in a semi-diurnal tidal setting with a meso-tidal range, the tidal wave propagates from west to east (i.e. high tide occurs from the west and moves eastward into the estuary). The tidal range within the site is heterogeneous. The site is located circa 200 m offshore, with the closest shoreline being to the north and east of the site. Currents are predominately determined by the tide flowing in and out of the Waterway in a semi-diurnal cycle with sediment accumulation on the periphery of the bay at the Dale Roads site (site 7) with mud flat backed by sandstone. The site is characterised by medium sand (0.06-0.25 mm) over silt/clay (Germano & Assoc. Ltd, 2012). The material is very poorly sorted with material being finer at the north west corner of the site. Dale Roads supports depths of between 8 and 12 metres CD and benefits from a significant wind and wave fetch from the south and southwest.
- 5.6.1.10 The location of this bay to the north of the main channel gives rise to tidal currents which are much smaller in magnitude than the main channel; typically, less than 0.25 m/s. However, the area is exposed to waves approaching from the south west therefore littoral currents would be important during storm events and not restricted to the direction of tidal flows. The assessment of wave climate undertaken under SEACAMS2 (Yin *et al.*, 2018) demonstrated that the maximum significant wave height experienced in this region was 4 m with a mean value of 1.5 m.
- 5.6.1.11 Hard, red calcareous marls with sporadic red and green sandstones make up the geology of much of the Waterway. Basal beds of green marl, conglomerate and breccia are also present. Near the mouth of the Waterway at Dale Roads (site 7), which is exposed to the greatest wave action, the intertidal and subtidal areas are largely coarse sediments and bedrock. Dale Roads (site 7) is situated within a bay and as such sediment transport is expected to migrate from the two peninsulas towards the centre of the bay. The site will experience significant suspended sediment concentrations, particularly during storm conditions both as a result of exposure to waves and increased fluvial sediment source within the coastal processes study area. 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).
- 5.6.1.12 Chapter 7: Benthic Subtidal and Intertidal Ecology, section 7.7.2.12 describes the sediment types and size predicted at Dale Roads (site 7). EUSeaMap (2016) data predict largely high energy infralittoral seabed sediments coinciding with Dale Roads (site 7) with some areas of Atlantic and Mediterranean high energy infralittoral rock. SPI survey data that coincides with this site identify the area as a combination of 'Central Mixed Physical', 'Central Sand Physical' and 'Marginal Physical' habitats corresponding to the 'Poorly sorted muddy sand, shells, pebbles', 'wave rippled sand' and 'mixed rounded talus, sand mud' facies, respectively. The surface grain size classification was very fine to fine sand (Germano and Associates, 2013).

### East Pickard Bay (site 8)

- 5.6.1.13 Tidal range within the East Pickard Bay site (site 8) remains fairly consistent with minimal variation throughout seasonal cycles. The predominate current runs from an east to west direction through the site, and a strong rip tide can be found at the south of Freshwater West Bay. East Pickard Bay (site 8) is exposed to a good wave resource benefiting from a 200 km fetch from the prevailing wind direction and has a water depth of between 10 and 29 m CD.
- 5.6.1.14 The East Pickard site (site 8) is located 0.5 km from the shoreline to the north east which consist of rock cliffs with rocky outcrops. The eastern extent of the site is 0.75 km from the north west edge of Freshwater West Bay, which comprises a sandy beach 0.5 km wide at low water and backed by dunes.
- 5.6.1.15 The assessment of wave climate undertaken under for the a potential WEC site (ABPmer Ltd *et al.*, 2018) demonstrated that the maximum significant wave height experienced within the site is 10 m at the deeper south west end of the site reducing to 5 m at the shallower eastern end. More typical offshore mean wave conditions give rise to significant wave heights circa one third of the maximum values. Current meter deployments within the East Pickford site indicated that tidal currents of 0.3 m/s are common with flood currents being marginally smaller in magnitude. However due to the exposure of the site, wave induced flow can be significant as incoming waves from the south west sector are refracted off the cliffs. This mechanism can give rise to complex flow patterns and in significant events the resulting current speed may be far larger than the tidal flow component.
- 5.6.1.16 The geology is comprised of hard, red calcareous marls with sporadic red and green sandstones. Basal beds of green marl, conglomerate and breccia are also present. East Pickard Bay (site 8) is a high energy environment and as such sediments are primarily made up of coarse sediment types (gravel and sand) these are more predominant to the south of the site whilst the north west is characterised by subtidal reef. Sampling at the eastern end of the site undertaken as part of the SEACAMS2 project update indicated compacted coarse sand 0.5 – 1 mm diameter. Within the vicinity of East Pickard Bay (site 8), the wave climate will be the main influence on offshore sediment transport rather than tidal currents due to the high energy environment. Bedload sediment transport is primarily moved from west to east and deposited on Freshwater West beach. Suspended sediment levels in the area would have typical monthly averages of 1-2 mg/l in summer and 10 mg/l in winter but this may increase to 15 mg/l during storm events (CEFAS, 2016).
- 5.6.1.17 Chapter 7: Benthic Subtidal and Intertidal Ecology, section 7.7.2.14 describes the sediment types and size predicted at East Pickard Bay (site 8). EUSeaMap (2016) data predict Atlantic and Mediterranean high energy circalittoral rock in the nearshore area to the north of the East Pickard Bay (site 8) boundary. This sediment type is also predicted to extend offshore.

## 5.6.2 Designated sites

5.6.2.1 All sites supporting Phase 2 activities are present within the Pembrokeshire Marine/ Sir Benfro Forol SAC (a Natura 2000 site) and as such are protected under the Habitats Directive (1992). Therefore, the coastal processes were examined for each site and activity to provide information for each EIA technical assessment.

## 5.6.3 Future baseline scenario

5.6.3.1 The (Marine Works (EIA) Regulations 2007 (as amended)) 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.

5.6.3.2 The baseline environment for coastal processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the proposed developments in place due to naturally occurring and ongoing processes. Any potential impacts identified due to the proposed META project must therefore be viewed in the context of the changes that might occur over the timescales of the developments.

5.6.3.3 Due to climate change, mean sea level is expected to rise in the 21<sup>st</sup> Century. A rise in sea level has potential to allow larger waves and therefore more wave energy to reach areas of the Waterway and the surrounding coastline that are currently exposed to notable wave energy. There may also be changes to storm surges in the future as a result of climate change, and potentially impacts on the wave regime itself, although it is noted that there are large uncertainties with respect to those changes, particularly with respect to the wave climate.

## 5.6.4 Data limitations

5.6.4.1 The nature of the META project facility means that a range of installations may be undertaken in both varying sites and device types. However, the scale of the devices and temporary nature of their installation indicates that the magnitude of impacts would be small. There is a large amount of data available with the study area and environs as it has been closely monitored by the MHESG for many years and reviewed under the Shoreline Management Plan (Halcrow, 2012). Therefore, no new data is needed to allow a proportionate impact assessment to be undertaken and there is a high level of certainty in the conclusions of the assessment.

## 5.7 Key parameters for assessment

### 5.7.1 Maximum and most likely design scenario

5.7.1.1 The maximum design scenarios identified in Table 5.3 have been selected as those having the potential to result in the greatest effect on an aspect of coastal processes. 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 based on details within the Project Design Envelope, to that assessed here be taken forward in the final design scheme.

5.7.1.2 The most likely design scenarios identified in Table 5.3 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).

Table 5.3: Maximum and most likely design scenarios for the META project.

Potential impact	Maximum design scenario	Most likely design scenario	Justification
<b>Installation phase</b>			
Increases in SSC and deposition of disturbed sediment to the seabed.	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Installation of gravity base 25 m<sup>2</sup>. Up to four drag anchors</li> <li>No use of DP vessels</li> <li>Up to 5 m strip of seabed clearance around seabed footprint (200 m<sup>2</sup>) which equates to 330 m<sup>2</sup></li> <li>Up to four device deployments in a 12-month period</li> </ul>	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Device supported by test support buoy or vessel</li> <li>No use of DP vessels</li> <li>No seabed preparation required</li> <li>Up to two device deployments in a 12-month period</li> </ul>	Sediment disturbance may arise from a range of installation activities within the site, such as foundation installation and drilled pin piling. Elevations in SSC and subsequent deposition of disturbed sediments have the potential to result in adverse and indirect impacts on a variety of receptor groups. The greatest potential for SSC is considered likely to arise from gravity base deployments, or devices touching the seabed.
	<p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Up to 10 drag anchors or gravity base up to 500 m<sup>2</sup></li> <li>Potential use of DP vessel during installation</li> <li>Up to 5 m strip of seabed clearance around seabed footprint (600 m<sup>2</sup>) which equates to 510 m<sup>2</sup></li> <li>Up to two devices deployed in a 12-month period</li> </ul>	<p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Dynamic tether mooring system of up to four standard drag embedment anchor or gravity base 75 m<sup>2</sup></li> <li>No seabed preparation required</li> <li>Up to one device deployment in a 12-month period</li> </ul>	
	<p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Up to three-point catenary mooring system, or up to 10 standard drag embedment anchors or gravity base up to 1125 m<sup>2</sup></li> <li>Potential use of DP vessel during installation</li> <li>Up to 10 m strip of seabed clearance around seabed footprint (8,000 m<sup>2</sup>) which equates to 3,486 m<sup>2</sup></li> <li>Up to four devices deployed in a 12-month period</li> <li>Up to 120,000 m<sup>2</sup> from mooring spread for deployment vessels for up to two test activities at any one time</li> </ul>	<p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Up to 4 standard drag embedment anchors or gravity base up to 1125 m<sup>2</sup></li> <li>Potential use of DP vessel during installation</li> <li>No seabed preparation required</li> <li>Up to one device deployed in a 12-month period</li> <li>Up to 70,000 m<sup>2</sup> from mooring spread for up to one test activity</li> </ul>	
Release of contamination adsorbed to sediments disturbed, on ecological receptors.	As for "Increases in SSC and deposition of disturbed sediment to the seabed"	As for "Increases in SSC and deposition of disturbed sediment to the seabed"	As for "Increases in SSC and deposition of disturbed sediment to the seabed".
<b>Operation and maintenance phase</b>			
Increases in SSC and deposition of disturbed sediment to the seabed	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Rotor diameter ≤ 5 m</li> </ul>	<p><b>Warrior Way</b></p>	Sediment disturbance may affect environmental receptors by increasing the amount of SSC present within the designated sites. During the operation and maintenance phase it is not considered likely that wave devices would disturb sediment on the seabed. If they were to have any impact it would be to

Potential impact	Maximum design scenario	Most likely design scenario	Justification
	<ul style="list-style-type: none"> <li>Speed of moving parts &lt; 5 m/s</li> <li>Swept area up to 19.63 m<sup>2</sup></li> <li>Up to four devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>May occupy all of the water-column</li> <li>Up to 150 m<sup>2</sup> of temporary habitat disturbance from a single mooring spread at any one time</li> </ul>	<ul style="list-style-type: none"> <li>Rotor diameter ≤ 5 m</li> <li>Speed of moving parts &lt; 2 m/s</li> <li>Swept area up to 19.63 m<sup>2</sup></li> <li>Up to two devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>May occupy all of the water-column</li> <li>Up to 75 m<sup>2</sup> of temporary habitat disturbance from a single mooring spread at any one time</li> </ul>	reduce potential sediment disturbance as energy is extracted from the environment through the operation of the devices. As such Dale Roads (site 7) and East Pickard Bay (site 8) have not been considered further within this impact assessment.
Changes to the wave regime, with associated impacts on adjacent coastlines.	<p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Device dimensions up to 30 x 20 m</li> <li>Up to two devices deployed in a 12-month period</li> </ul>	<p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Device dimensions up to 15 x 10 m</li> <li>Up to one device deployment in a 12-month period</li> </ul>	The interaction of operational marine energy devices and associated infrastructure and the wave regime may result in a reduction to wave energy. This in turn has the potential to impact upon adjacent coastlines. As Warrior Way (site 6) is for the testing of tidal devices, this site has not been assessed for this impact.
	<p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Device dimension up to 147 x 230 m</li> <li>Up to four devices deployed in a 12-month period</li> </ul>	<p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Device dimensions up to 80 x 17 m</li> <li>Up to one device deployed in a 12-month period</li> </ul>	
Changes to the hydrodynamic regime due to the operation of tidal turbines	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Rotor diameter ≤ 5 m</li> <li>Speed of moving parts &lt; 5 m/s</li> <li>Swept area up to 19.63 m<sup>2</sup></li> <li>Up to four devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>Up to one device deployed at any one time</li> <li>May occupy all of the water-column</li> </ul>	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Rotor diameter ≤ 5 m</li> <li>Speed of moving parts &lt; 2 m/s</li> <li>Swept area up to 19.63 m<sup>2</sup></li> <li>Up to two devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>Up to one device deployed at any one time</li> <li>May occupy all of the water-column</li> </ul>	Tidal current devices which employ impeller or turbine technology extract kinetic energy from the tidal flow and therefore have the potential to change the hydrodynamic regime. Where large turbine arrays are implemented tidal flow may be deflected around the installation. The Warrior Way site (site 6) is the only META site where a single device of this type of will be deployed therefore Dale Roads (site 7) and East Pickard Bay (site 8) have not been considered further within this impact assessment.
	Scour of seabed sediments	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Installation of gravity base 25 m<sup>2</sup>. Up to four drag anchors</li> <li>Up to four devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Up to 10 drag anchors or gravity base up to 500 m<sup>2</sup></li> <li>Up to four x 100 mm pin piles</li> <li>Up to two devices deployed in a 12-month period of which 50% may touch the seabed</li> </ul>	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Device supported by test support buoy or vessel</li> <li>Up to two devices deployed in a 12-month period</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>No pin piles</li> <li>Dynamic tether mooring system of up to four standard drag embedment anchor or gravity base 75 m<sup>2</sup></li> </ul>

Potential impact	Maximum design scenario	Most likely design scenario	Justification
Impacts to sediment transport and sediment transport pathways	<ul style="list-style-type: none"> <li>Up to one device deployed at any one time</li> </ul> <p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Up to three-point catenary mooring system, or up to 10 standard drag embedment anchors or gravity base up to 1125 m<sup>2</sup></li> <li>Up to four x 100 mm pin piles</li> <li>Up to four devices deployed in a 12-month period of which 50% may touch the seabed</li> <li>Up to two devices deployed at any one time</li> </ul>	<ul style="list-style-type: none"> <li>Up to one device deployed in a 12-month period of which 50% may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Up to 4 standard drag embedment anchors or gravity base up to 1125 m<sup>2</sup></li> <li>No pin piles</li> <li>Up to once device deployed in a 12-month period. Up to 50% of devices may touch the seabed</li> <li>One device deployed at any one time</li> </ul>	Foundations used for marine energy devices may interrupt sediment transport pathways.
	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Installation of gravity base 25 m<sup>2</sup></li> <li>Up to four devices deployed in a 12-month period, 50% of which may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Bed mounted device 600m<sup>2</sup></li> <li>Up to two devices deployed in a 12-month period of which 50% may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Gravity base 1125 m<sup>2</sup> for 18 months</li> <li>Up to four devices deployed in a 12-month period of which 50% may touch the seabed</li> <li>Up to two devices deployed at any one time</li> </ul>	<p><b>Warrior Way</b></p> <ul style="list-style-type: none"> <li>Device supported by buoys</li> <li>Up to two devices deployed in a 12-month period</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>Dale Roads</b></p> <ul style="list-style-type: none"> <li>Tether mooring or gravity base 75 m<sup>2</sup> for 12 months</li> <li>Up to one device deployed in a 12-month period. Up to 50% of devices may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul> <p><b>East Pickard Bay</b></p> <ul style="list-style-type: none"> <li>Gravity base 1125 m<sup>2</sup> installed for 12 months</li> <li>Up to once device deployed in a 12-month period of which 50% may touch the seabed</li> <li>Up to one device deployed at any one time</li> </ul>	
<b>Decommissioning phase</b>			
Increases in SSC and deposition of disturbed sediment to the seabed	As installation phase	As installation phase	Removal of marine energy devices and infrastructure may result in re-suspension of sediments.

## 5.7.2 Impacts scoped out of the assessment for Coastal Processes

5.7.2.1 No impacts have been scoped out of the Coastal Processes assessment.

## 5.8 Impact assessment methodology

### 5.8.1 Overview

5.8.1.1 The Coastal Processes EIA has followed the methodology set out in chapter 4: Environmental Impact Assessment Methodology. The nature of the META facility means that a range of installations may be undertaken at the META project sites and a range of device types may be installed, however Warrior Way (site 6) will only support scaled or micro-scaled tidal turbines, and Dale Roads (site 7) and East Pickard Bay (site 8) will support wave energy device testing and may also support floating offshore wind component testing. In order to negate any uncertainty introduced by generalised test areas each potential impact was assessed using a conservative project design envelope. For example, for analysis of the potential impact of device installation on seabed sediment, the device with the largest footprint would be assumed to be installed using the most disruptive technique whilst the wave climate assessment may examine a different device which has a greater impact on waves (but less so on seabed sediment). Thus, the maximum impact would be assessed even for the most likely design scenario.

5.8.1.2 In the case of some of potential impacts considered in this chapter, coastal processes are not in themselves receptors. However, changes to coastal processes arising due to the development have the potential to indirectly impact other receptors in the marine environment. For example, increases in suspended sediments during the installation phase of the META project may lead to the settling of these sediments (and smothering of benthic habitats). As such, this coastal process assessment has been undertaken to inform a range of other technical assessments presented across the Environment Statement. The pathways assessed are:

- Increases in SSC and deposition of disturbed sediment to the seabed (installation and decommissioning phase);
- Release of contamination adsorbed to sediments disturbed, on ecological receptors (installation and decommissioning phase); and
- Increases in SSC and deposition of disturbed sediment to the seabed (operation and maintenance phase).

5.8.1.3 In the case of these impact pathways, the coastal process assessment evaluates the likely process changes and their magnitude and does not present a sensitivity or significance of impact. The potential significance of impacts of these changes are assessed in the following receptor chapters (with sensitivity of receptor also being presented in these chapters):

- Benthic Subtidal and Intertidal Ecology (chapter 7);
- Fish and Shellfish (chapter 8);

- Marine Mammals, Basking Shark and Otter (chapter 9);
- Marine Ornithology (chapter 10);
- Commercial Fisheries (chapter 11);
- Marine Archaeology (chapter 13); and
- Other Users (chapter 16).

5.8.1.4 Whilst coastal processes can largely be considered pathways, a number of coastal process receptors have also been identified and are assessed in this chapter. A full impact assessment is presented within this coastal process assessment for these receptors. These are:

- Changes to the wave regime, with associated impacts on adjacent coastlines;
- Changes in hydrodynamic regime associated with tidal devices;
- Scour of sea bed sediments; and
- Impact on sediment transport and sediment transport pathways.

## 5.9 Assessment of significance

### 5.9.1 Installation phase

5.9.1.1 The impacts of the offshore installation of the META project have been assessed on coastal processes. The potential impacts arising from the installation of the META project are listed in Table 5.3, along with the maximum and most likely design scenarios against which each impact has been assessed. A conclusion of the scale of each effect will be made for the META project and for each META project site individually where appropriate (Warrior Way (site 6), Dale Roads (site 7); East Pickard Bay (site 8).

5.9.1.2 A description of the potential effect on coastal processes caused by each identified impact is given below.

#### ***Increases in SSC and deposition of disturbed sediment to the seabed***

5.9.1.3 Sediment disturbance may arise from a range of installation activities within the sites, such as foundation installation and drilled pin piling. In terms of increased suspended sediment concentrations, the greatest level of disturbance would be created by the installation of gravity bases or bed mounted devices where the seabed is levelled. The sandy nature of the sediments at each site would suggest the use of levelling techniques such as back hoe dredging which create relatively small quantities of suspended sediments.

## Magnitude of impact

### **Warrior Way (site 6)**

- 5.9.1.4 Warrior Way (site 6) has been identified as a test site for scaled or micro tidal devices. In the installation phase, increases in suspended sediment could arise from seabed disturbances due to the installation of moorings. The magnitude of the increase in suspended sediment can be approximated by examining the volume of material mobilised, the current speed and the bed material although the precise nature of any impact would be controlled by the tidal conditions at the time of installation. The Warrior Way (site 6) bed is characterised by mixed coarse, gravely marine sand.
- 5.9.1.5 By way of illustration, to quantify these effects it is assumed that across the area of the maximum dimension gravity base (25 m<sup>2</sup>) there is a disparity in level of 0.5 m and therefore requires levelling by an average depth of 0.25 m totalling 6.25 m<sup>3</sup> of material to be redistributed. The material at this site varies in size from 1 – 64 mm so if it is assumed that 20 % of the material lies within the finer range and could be brought into suspension. Back hoe dredging operations typically having a spill rate of < 5 % therefore circa 100 kg would be released into the water column (loose sand having a density of 1350 kg/m<sup>3</sup>). Based on the sediment characteristics and tidal currents, the finest material would travel in the order of 100 m from the site during an average tide. The coarsest material would travel less than one tenth of this distance and a large proportion would come to rest within the site and the immediate area. This demonstrates that there would be no interaction with the other META sites should they be operated simultaneously.
- 5.9.1.6 Given the sandy nature of the bed, all but the finest material from the sediment plume would settle within a relatively short period after the works are complete (i.e. < 1 hour). Using the volume of material released and the range calculated, the plume itself would give rise to an average increase in SSC of 40 mg/l which is in the order of reported background levels during storm events. The only impact which persists after the installation is the redistribution of the seabed material. Under the conditions described here, a lozenge shape distribution would form, elongated in the axis of tide flow. The material itself is native to the area and would lie within the proposed test area, unless a very peripheral location is selected. The impact is therefore considered to be temporary in nature and overall of minor magnitude and would not cause cumulative impacts with the other META sites.
- 5.9.1.7 The example provided relates to the maximum design scenario with a 25 m<sup>2</sup> area gravity foundation. In practice it is more likely that the device would be supported by buoys with little or no disturbance to the bed sediments.

### **Dale Roads (site 7)**

- 5.9.1.8 Dale Roads (site 7) is more favourably suited to wave devices. As with Warrior Way (site 6) the installation phase increases in suspended sediment could arise from bed disturbances due to the installation of moorings. In the case of wave devices, the gravity base or bed mounted devices would cause greatest disturbance. The magnitude of the increase in suspended sediment can be approximated by examining the volume of material mobilised, the current speed and the bed material which is dominated by fine sand and silt varying from 0.06 – 0.25 mm. The precise nature of any impact would be controlled by the tidal conditions at the time of installation at Dale Roads (site 7) and would also be related to the range of depths and a large tidal range present at the site.
- 5.9.1.9 To illustrate these effects a similar exercise was undertaken as for Warrior Way (site 6) as described in paragraph 5.9.1.5. It is assumed that the area of the maximum dimension gravity base (500 m<sup>2</sup>) was levelled by an average depth of 0.25 m by back hoe dredging. As before the backhoe is assumed to have a spill rate of 5 % however in this area 50 % of the material is assumed to be fines and is brought up to half the average water depth. The very finest material (0.06 mm) would travel in the order of 600 m from the site during an average tide based on the average site current speed. The coarsest material would travel less than one tenth of this distance prior to settling. The plume would not reach or interact with any other META project sites should they be operational at the same time.
- 5.9.1.10 The plume itself would give rise to an average increase in SSC of 50 mg/l based on this volume of material and the potential plume extent; which is in the order of those experienced during storm conditions – but would be far less widespread and would settle in under 2 hours. The only impact which persists after the installation is the redistribution of the seabed material. Given the silty nature of the bed and the circulatory current it is anticipated that the material would be deposited within the bay from which it originated.
- 5.9.1.11 The example provided relates to the maximum design scenario and uses a conservative method to contextualise the potential impacts. In practice the site is more likely to be used for a smaller device utilising a more compact gravity base or anchored moorings. The impact on SCC is therefore predicted to be temporary in nature and of minor magnitude and would not interact with the other META sites.

### **East Pickard Bay (site 8)**

- 5.9.1.12 East Pickard Bay (site 8) will support testing of full-scale wave devices and floating offshore wind component testing. In the case of wave devices, the gravity base or bed mounted devices would cause greatest disturbance in bed sediments. The magnitude of the increase in suspended sediment can be approximated by examining the volume of material mobilised, the current speed and the bed material which is dominated by sandy marine gravels. As previously stated, precise nature of any impact would be controlled by the tidal conditions at the time of installation and the installation methodology used.

- 5.9.1.13 As with the other sites, to illustrate these effects it is assumed that the area of the maximum dimension gravity base was levelled by a depth of 0.25 m and material was spilt at half the average water depth. Of the 1125 m<sup>2</sup> area of gravelly marine sand the finest material (1 mm) would travel in the order of 50 m from the site during an average tide. The coarsest material would travel less than one fifth of this distance prior to settling. The plume would be limited in size and not be oriented towards Dale Roads (site 7), the closest META site; therefore, there would be no interaction. The use of a back hoe would release around three tonnes of material assuming a 5 % spill of 15 % finer material.
- 5.9.1.14 The plume itself would give rise to an average increase in SSC of 70 mg/l as the disturbance is more confined than those with finer sediment within the Waterway. Correspondingly the coarser nature of the material means the sediment plume would settle within a relatively short period after the works are complete i.e. < 1 hour. The only impact which persists after the installation is the redistribution of the seabed material due to the local bathymetric changes due to the levelling and settlement of material mobilised in the immediate vicinity during these operations.
- 5.9.1.15 The impact on SCC is therefore predicted to be temporary in nature and of minor magnitude and would not interact with the other META sites.
- 5.9.1.16 The example provided relates to the maximum design scenario and which is also the most likely scenario. However, the example presented uses the most arduous method of installation, i.e. plough dredging with very large bed disturbance.

#### **META project sites**

- 5.9.1.17 It has been demonstrated that at all three sites the areas of potential increases in SSC is limited and, should all sites be operated simultaneously, there would be no interaction or cumulative impact.

#### **Sensitivity of receptor and significance of impact**

- 5.9.1.18 No assessment of sensitivity of receptor or significance of impact is provided for this coastal process impact pathway, as these are assessed by the associated receptor group assessment (see section 5.8.1.3).

#### **Release of contamination adsorbed to sediments disturbed, on ecological receptors**

- 5.9.1.19 Contaminants including, asbestos, tin, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons, tributyltin and dibutyltin, lead and hydrocarbons may be found adsorbed to sediments. These sediments can be re-suspended through anthropogenic sources and taken up by biota present in the Study Area. The analysis of the suspended sediment presented may be used to inform the potential for contamination due to the installation of test devices.

#### **Magnitude of impact**

##### **Warrior Way (site 6)**

- 5.9.1.20 Of the three sites Warrior Way (site 6) would present the site where contaminants are found in the greatest concentrations (Little, 2009). However, the volume of sediments (< 10 m<sup>3</sup>) disturbed under the maximum design scenario using standard construction techniques is small and material does not remain suspended for a long period or redeposit at any great distance from the site. This is due to both the small scale of the installation and the nature of the bed material. The potential for contamination is therefore very low and would not extended to or interact with other META sites and therefore the magnitude of the impact is minor.

##### **Dale Roads (site 7)**

- 5.9.1.21 Far lower levels of contaminants are found at Dale Roads (site 7) (Little, 2009) as the site is located further from the industrial activity occurring in the Waterway and is well flushed and exposed to waves. The potential for contamination is therefore very low particularly in the context of maintenance dredging which is routinely undertaken within the coastal processes study area in the order of 3000 m<sup>3</sup> annually (Little, 2014) as opposed to the redistribution of 125 m<sup>3</sup> of material proposed at Dale Roads (site 7). The magnitude of the impact is therefore considered to be minor and would not cumulate with other META project sites.

##### **East Pickard Bay (site 8)**

- 5.9.1.22 The East Pickard Bay site (site 8) is located on the open coast. No contamination has been documented at this location therefore it is expected that there will be no release of contaminants under the maximum design scenario and the magnitude is therefore considered to be negligible.

#### **Sensitivity of receptor and significance of impact**

- 5.9.1.23 No assessment of sensitivity of receptor or significance of impact is provided for this coastal process impact pathway, as these are assessed by the associated receptor group assessment (see section 5.8.1.3).

#### **Further mitigation and residual effect**

- 5.9.1.24 No further mitigation is suggested.

#### **Future monitoring**

- 5.9.1.25 No monitoring is considered necessary with regards to the installation phase impact assessment.

## 5.9.2 Operation and maintenance phase

5.9.2.1 The impacts of the offshore operation and maintenance of the META project have been assessed on coastal processes. The potential environmental impacts arising from the operation and maintenance of the META project are listed in Table 5.3 along with the maximum and most likely design scenarios against which each operation and maintenance phase impact has been assessed. For each impact type, the maximum adverse scenario relative to that impact has been selected. For example, the much larger floating wave devices would have the greater impact of wave climate whereas bed mounted devices would have larger implications on bed sediment. A conclusion of significance of effect will be made for the META project as a whole, and for each META project site individually where appropriate (Warrior Way (site 6), Dale Roads (site 7); East Pickard Bay (site 8)).

5.9.2.2 A description of the potential effect on coastal processes caused by each identified impact is given below.

### ***Increases in SSC and deposition of disturbed sediment to the seabed***

5.9.2.3 During the operation and maintenance phase it is not considered likely that wave devices would disturb sediment on the seabed. If they were to have any impact it would be to reduce potential sediment disturbance as energy is extracted from the environment through the operation of the devices. As such Dale Roads (site 7) and East Pickard Bay (site 8) have not been considered further within this impact assessment.

### ***Magnitude of impact***

5.9.2.4 Warrior Way (site 6) is the only site to propose the testing of scale or micro-scaled tidal devices. The maximum design scenario proposes a turbine arrangement which occupies the majority of the water column therefore there is the potential for the disturbance of material on the seabed when the device is operational. The accelerated flow through the turbine may potentially mobilise sediment however this is largely device dependent.

5.9.2.5 The characteristics of the seabed (and the analysis undertaken for the installation phase 5.9.1.5) indicate that any material which is mobilised will re-deposit in the vicinity of the site once out of the influence of the turbine blades. The potential impact is therefore considered likely to be limited to within the site and not interact with any other META project sites.

5.9.2.6 The maximum design scenario indicates that the testing period will be limited to 6 months with the device in the water for 50 % of this time which would limit the potential for increased suspended sediment.

5.9.2.7 The most likely scenario is that any device would be much smaller and therefore unlikely to impact on bed sediment.

5.9.2.8 The magnitude of the effect is therefore considered to be temporary and minor.

### ***Sensitivity of receptor and significance of impact***

5.9.2.9 No assessment of sensitivity of receptor or significance of impact is provided for this coastal process impact pathway, as these are assessed by the associated receptor group assessment (see section 5.8.1.3).

### ***Changes to the wave regime, with associated impacts on adjacent coastlines***

5.9.2.10 The abstraction of wave energy can potentially alter the wave climate and disturb sediment transport regimes in an area. The maximum abstraction of energy from any wave device considered for use in the META site is 20 %. It should be noted that Warrior Way (Site 6) has been scoped out of this assessment as this site is only proposed to support testing of tidal devices.

### ***Magnitude of impact***

#### ***Dale Roads (site 7)***

5.9.2.11 The impact of the maximum design scenario device was examined for the peak and mean wave climates. In the case of the peak wave climate the 4 m significant wave height would be reduced by 0.5 m along the 30 m length of the device, and the wave front would return to uniformity within two wavelengths of the extraction or 100 m beyond the device. In the case of mean wave climate, a 1.5 m wave would be reduced by 200 mm and the wave front would return to uniformity in 50 m.

5.9.2.12 The largest device considered at this site occupies less than 2 % of the 1.5 km wave front which enters Dale Roads (site 7) and the energy extraction constitutes < 0.4 % of the incident mean wave energy. The wave climate would return to uniformity within the site boundaries and not impact on the intertidal zone. For the maximum design envelope the device would be in place for up to 12 months after which the wave climate would return to the previous situation.

5.9.2.13 The most likely design is for a device one half of the length of the maximum design scenario and in place for up to 6 months. Therefore, the energy extraction would be less than 0.2 % of the mean incident wave.

5.9.2.14 The magnitude of the impact on wave climate is therefore considered to be minor.

### ***East Pickard Bay (site 8)***

- 5.9.2.15 The impact of the maximum design scenario device was examined for the peak and mean wave climates. In the case of the peak wave climate the 5 m significant wave height would be reduced by 0.5 m along the 230 m length of the largest device and the wave front would return to uniformity 150 m beyond the device. In the case of mean wave climate, a 2 m wave would be reduced by 200 mm and the wave front would return to uniformity in 80 m.
- 5.9.2.16 The incoming waves at East Pickard Bay (site 8) approach from the south west therefore any disruption due to energy extraction within this site would occur between the wave device and the adjacent cliffs/coastline to the north of the site. Energy devices located to the east of the test area would not disrupt waves approaching Freshwater West Bay.
- 5.9.2.17 The largest device considered at this site occupies less than 5 % of the 5 km wave front which enters East Pickard Bay (site 8) and the energy extraction constitutes < 1 % of the incident mean wave energy. The wave climate would return to uniformity prior to reaching the intertidal zone. For the maximum design envelope, the device would be in place for up to eighteen months after which the wave climate would return to the previous situation.
- 5.9.2.18 The most likely design is for a device one third of the length of the maximum design scenario and in place for up to 6 months. Therefore, the energy extraction would be less than 0.4 % of the mean incident wave.
- 5.9.2.19 The magnitude of the impact of wave climate is therefore considered to be minor.

### **Sensitivity of receptor**

#### ***Dale Roads (site 7)***

- 5.9.2.20 The reduction in wave energy of < 0.4 % and a wave field which is resolved outside of the inter-tide domain would have no significant effect on sediment transport regimes. The variation in the wave climate would be inshore of any device therefore no cumulative effects would be impact Dale Roads (site 7).
- 5.9.2.21 The sensitivity of the receptor is therefore deemed to be low.

#### ***East Pickard Bay (site 8)***

- 5.9.2.22 The reduction in wave energy of < 1 % and a wave field which is resolved outside of the inter-tide domain would have no significant effect on sediment transport regimes in terms of an EIA. Wave climate variations would occur inshore of the site therefore they would not interact with those from the Dale Roads Site (site 7) should the sites be operated simultaneously.
- 5.9.2.23 The sensitivity of the receptor is therefore deemed to be low

### **Significance of the effect**

#### ***Dale Roads (site 7)***

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

#### ***East Pickard Bay (site 8)***

- 5.9.2.25 Overall, the sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor. The effect will, therefore, be of **minor adverse significance**, which is not significant in EIA terms.
- 5.9.2.26 Overall (all relevant META sites) no differences in the magnitude of the impact or the sensitivity of the receptors are noted, therefore the significance of the META project overall is considered to be of minor (adverse) significance, which is not significant in EIA terms.

### ***Changes in hydrodynamics associated with tidal devices***

- 5.9.2.27 Tidal current devices which employ impeller or turbine technology extract kinetic energy from the tidal flow. They therefore have the potential to change the hydrodynamic regime. The Warrior Way site (site 6) is the only META site where this type of device will be deployed. This site will enable the testing of scaled and micro tidal power devices on a short-term basis (up to 6 months). Studies of offshore resources have determined that even installations at full scale with a limited number of devices have a marginal influence on tidal flows, and large-scale arrays are required to produce significant changes.
- 5.9.2.28 By way of example, in Strangford Lough (Marine Current Turbines (MCT), 2005) a twin turbine was installed with each rotor being of 16 m diameter. The impact of turbine operation of near field flows downstream of the rotors was found to be negligible, based on Computational Fluid Dynamics (CFD) modelling and observations from the Seaflow prototype. Velocity differences away from the immediate area were less than 1% of typical tidal velocities. This was considered to be an insignificant difference in the context of the range of speeds encountered throughout the Strangford Lough narrows.

### Magnitude of impact

#### **Warrior Way (site 6)**

- 5.9.2.29 An analysis was undertaken using the maximum design proposed for the Warrior Way site (site 6). An assessment of a 5 m diameter turbine placed at the location indicated on Figure 5.2 determined that the sweep area of the blade constituted 0.35% of the cross-sectional area of the channel, at the mean water level. Applying a normalised power curve (Shannon, 2011) the drag co-efficient for a turbine working within optimal parameters would be 0.4, i.e. extraction of 40% of the energy passing through the sweep area. Applying this parameter to the proposed device showed a potential reduction in the energy across the channel of < 0.15%.
- 5.9.2.30 The localised reduction in current speed in the immediate sweep area was 2% which is in the order of 0.035 m/s at peak current speeds. Therefore, there would not be any change in the flow regime, with indiscernible changes in current speed outside the immediate area. With respect to the Strangford Lough study (MCT, 2005), results of CFD suggested that the downstream influence (wake) of the entire structure is unlikely to cover an area greater than 1.5 times the diameter. Therefore, if this principle is applied to Warrior Way (site 6), any minor flow disruption would lie within the boundary of the consented test area.
- 5.9.2.31 The Copelands study (Shannon, 2011) compared the flow behaviour of single deployment and a range of array types. It demonstrated that where flow is unconfined, tidal currents will take the path of least resistance and will flow around a single tidal structure. Therefore, the energy extraction potential may be reduced and a co-efficient of 0.4 would be considered conservative. In reality, the reduction in stream energy would also be lower, particularly when current speeds are reduced around slack water and optimum operational conditions are no longer maintained.
- 5.9.2.32 The magnitude of the impact of changes in the hydrodynamic regime due to the operation of tidal turbines at Warrior Way (site 6) is therefore considered to be minor.

### Sensitivity of Receptor

#### **Warrior Way (site 6)**

- 5.9.2.33 The reduction in tidal energy of <0.15% across the channel and a wake of <10 m would have no influence on the hydrodynamic regime. The variation in tidal currents would be well within the test area, and therefore no cumulative effects would impact on any other test area.
- 5.9.2.34 The sensitivity of the receptor is therefore deemed to be low.

### Significance of the effect

#### **Warrior Way (site 6)**

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

### Scour of seabed sediments

- 5.9.2.36 Interaction between the metocean regime (wave, sand and currents) and marine energy devices has the potential to cause localised scouring of seabed sediments leaving a depression around the structure. The magnitude of the potential scouring is both site and device specific; particularly where the structure occupies part of the water column. For example, although a bed mounted wave device has a larger footprint than a gravity base the profile is generally lower; so flow can pass freely over the device (and avoid energy loss due to flow disturbance). One would expect a limited amount of localised scour but generally less than a gravity base placed on the bed.
- 5.9.2.37 The size of the base also does not necessarily determine the scale of scour induced, for example a large gravity base may develop flow separation either side of the structure whereas a smaller structure may have turbulent interaction in the lee of the structure exacerbating scour and requiring further mitigation.
- 5.9.2.38 The presence or amount of scour depends on a number of parameters; the structure i.e. its shape, the width presented to the oncoming flow and the height of the structure with respect to the water column. It also depends on the flow characteristics i.e. current speed and orientation. Finally, it depends on the bed material; the sediment size, cohesion and depth. All of these items are variable across each site, for each device and for each foundation type.
- 5.9.2.39 The design of these measures would be required as part of each testing project undertaken within the META project testing area. Those structures most prone to scour are long-term installations such as offshore wind farm piles which are not proposed at the META project. Due to the limited nature and duration of the installation and testing at Warrior Way (site 6) seabed scour has been scoped out.

### Magnitude of impact

#### **Dale Roads (site 7)**

- 5.9.2.40 For the maximum design envelope, the use of pin piles is proposed. Site conditions in Dale Roads (site 7) indicate that the bed is mobile at the site therefore the maximum scour depth could be twice the pile diameter (Whitehouse *et al*, 2008) provided that unlimited depths of unconsolidated material exist. For the pin piles proposed this would be in the order of 200 mm, however due to the relatively low current speeds in this area the scour would be anticipated to be of much smaller magnitude. These low current speeds are also unlikely to cause significant scour should gravity bases be deployed.

5.9.2.41 This estimate is based on the maximum design envelope. The most likely scenario does not anticipate the use of piled foundations. It should be noted that the magnitude of scour potential would be specific to the foundation type selected and an assessment of scour would be undertaken on a case by case basis (see paragraphs 5.9.2.51 and 5.9.2.52).

5.9.2.42 Considering the short-duration and local spatial extent of testing proposed, the magnitude of the impact is considered to be minor.

**East Pickard Bay (site 8)**

5.9.2.43 As with Dale Roads (site 7), the maximum design envelope proposes the use of pin piles. Site conditions in East Pickard Bay (site 8) indicate that the bed is mobile, although material is coarser marine sands at this location. Similarly, the maximum scour depth could be twice the pile diameter (Whitehouse *et al.*, 2008). For the pin piles proposed this would be in the order of 200 mm, however due to the relatively coarse bed material in this area the scour would be anticipated to be much less.

5.9.2.44 This estimate is again based on the maximum design envelope. The most likely scenario does not anticipate the use of piled foundations. Likewise, detailed foundation design would quantify the potential for scour and provide mitigation if required.

5.9.2.45 Considering the short-duration and local spatial extent of testing proposed, the magnitude of the impact of scour on the seabed is considered to be minor.

**Sensitivity of receptor**

**Dale Roads (site 7)**

5.9.2.46 In areas where pin piles may be used the scour depth are likely to be in the order of 200 mm and will only occur in the immediate vicinity of the structure and will not interact with other sites. The flow regime will return to that previously experienced on removal of the piles. The sensitivity of the receptor is therefore deemed to be low.

**East Pickard Bay (site 8)**

5.9.2.47 In areas where pin piles may be used the scour depth are likely to be in the order of 200 mm and will only occur in the immediate vicinity of the structure and will not interact with other sites. The flow regime will return to that previously experienced on removal of the piles. The sensitivity of the receptor is therefore deemed to be low.

**Significance of the effect**

**Dale Roads (site 7)**

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

**East Pickard Bay (site 8)**

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

5.9.2.50 Overall (all relevant META sites) no differences in the magnitude of the impact or the sensitivity of the receptors are noted, therefore the significance of the META project overall is considered to be of minor (adverse) significance, which is not significant in EIA terms. This impact may be further reduced by detailed foundation design.

**Further mitigation and residual effect**

5.9.2.51 There is a degree of uncertainty in the assessment of scour presented, as potential for scour is likely to be affected by specific foundation type, deployment site and marine energy device design proposed for testing at META project sites.

5.9.2.52 The scour assessment based on the META Project Description that has been presented is considered to assess a maximum adverse scenario in relation to potential scour effects, however given the potential for seabed scour to be affected by the parameters outlined above, as a precautionary measure, desktop assessment of scour will be undertaken prior to installation of devices or components on a case by case basis. Detailed foundation design will establish where scour may be an issue and provide mitigation as appropriate.

**Impacts to sediment transport and sediment transport pathways**

5.9.2.53 Foundations used for marine energy devices may interrupt sediment transport pathways. The scale of this disruption will depend firstly on whether a pathway exists in the site of deployment and secondly the proportion of the pathway obstructed. It should be noted that at all sites, the deployments are temporary and after decommissioning the pathway will be restored.

**Magnitude of impact**

**Warrior Way (site 6)**

5.9.2.54 The Warrior Way site bed it comprised of relatively coarse sediments (i.e. fine to coarse sand), which indicates that finer fluvial material is transported from the estuary. However, the predominant sediment pathway would be located in the north of the channel as the current velocities are significantly greater.

- 5.9.2.55 The maximum design scenario providing the maximum obstruction on the bed would be a 5 m gravity base which would constitute a reduction of < 1 % in the width of the pathway. This gravity base would be in place for a maximum of 6 months. The site can support one device and up to four deployments may be undertaken in a 12 month period.
- 5.9.2.56 The most likely design scenario does not include any infrastructure which would impact on bed sediment transport.
- 5.9.2.57 Considering the short-duration and local spatial extent of testing proposed, the magnitude of the impact on sediment transport pathways is considered to be minor.

**Dale Roads (site 7)**

- 5.9.2.58 Dale Roads (site 7) is suited for the deployment of wave energy devices. In the case of wave devices, the gravity base or bed mounted devices would cause the largest obstruction to sediment pathways. The bed sediment at Dale Roads (site 7) is fine sand and silt therefore even though the tidal flows are low there is sediment transport within the bay. This occurs in a circulatory pattern around the bay, with reduced bed transport at the bay's centre. Due to the fine nature of the bed, sediment would be transported in suspension in addition to bed load.
- 5.9.2.59 The largest bed structure to be proposed under the maximum design scenario is 600 m<sup>2</sup> which would constitute less than 0.1% of the area of the bay or a reduction of < 4 % in the width of the pathway (i.e. one half the width of the bay assuming circulatory transport). It should be noted that the device would not be located within the shallow and intertidal zones where bed transport is more pronounced. The obstruction would be removed after a period of, at most 12 months after which sediment pathways would be restored.
- 5.9.2.60 The most likely design would be a smaller device of less than one third the dimension of the maximum scenario.
- 5.9.2.61 Considering the short-duration and local spatial extent of testing proposed, the magnitude of the impact on sediment transport pathways is considered to be minor.

**East Pickard Bay (site 8)**

- 5.9.2.62 Akin to Dale Roads (site 7), the East Pickard Bay site (site 8) is well suited to wave energy conversion devices. However, in this case the maximum and most likely design scenarios are the same in terms of the scale of a bed mounted device. The device has an area of 1125 m<sup>2</sup> however the structure is four times the width than length; with the long axis aligned to the incident wave. At this site that is approximately east-west with 90 % of waves approaching from the south and south-west sectors.

- 5.9.2.63 At this location the principle direction of bed load sediment transport is west to east therefore the width of obstruction will be the smallest axis of the device at < 20 m which is insignificant with respect to this open coast site. The device would be tested for a maximum period of 18 months after which time normal transport pathways would be restored.

- 5.9.2.64 Considering the short-duration and local spatial extent of testing proposed, the magnitude of the impact on sediment transport pathways is considered to be minor.

**Sensitivity of receptor**

- 5.9.2.65 No difference in sensitivity of receptor has been noted between the three META project sites, therefore the conclusion of magnitude is the same for all three.
- 5.9.2.66 In all three areas the reduction in sediment pathway is not significant and at no location is a pathway blocked by any significant extent, i.e. material is free to move around the device. There would be no significant effect on sediment transport beyond the immediate vicinity of each device and therefore no interaction if sites were to be operated concurrently. In each case the deployment is temporary and when a device is decommissioned bed sediment transport would return to the previous situation. At all three sites the sensitivity of the receptor is therefore deemed to be low.

**Significance of the effect**

**Warrior Way (site 6)**

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

**Dale Roads (site 7)**

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

**East Pickard Bay (site 8)**

- 5.9.2.69 Overall, the sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be minor. The effect will, therefore, be of **minor adverse significance**, which is not significant in EIA terms.
- 5.9.2.70 Overall (all relevant META sites) no differences in the magnitude of the impact or the sensitivity of the receptors are noted, therefore the significance of the META project overall is considered to be of minor (adverse) significance, which is not significant in EIA terms.

### *Future monitoring*

- 5.9.2.71 No monitoring during the operation and maintenance phase is considered necessary.
- 5.9.2.72 In general terms, during the operation and maintenance phase, the impacts are predicted to be of local spatial extent, typically < 500 m, and of a duration equal to the deployment period. The impacts would be reversed following decommissioning of each device.

### **5.9.3 Decommissioning phase**

- 5.9.3.1 The effects of decommissioning activities are expected to be the same or similar to the effects from construction/installation in that suspended sediment may be increased for a short period. The scale of disturbance would be less than any dredging activity cited in section 5.9.1. and there would be no interaction between the three META sites.

## **5.10 Cumulative Impact Assessment methodology**

- 5.10.1.1 The Cumulative Impact Assessment (CIA) takes into account the impact associated with the META project together with other projects and plans as detailed in Table 5.4. The projects and plans selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise which considered the full range of projects as detailed in Appendix 4.4 – Cumulative Impact Assessment projects considered in the Environmental Statement. 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.
- 5.10.1.2 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 operational stage 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.

Table 5.4: List of other projects and plans considered within the CIA.

Phase	Developer - Reference	Distance (km) from Warrior Way (site 6)	Distance (km) from Dale Roads (site 7)	Distance (km) from East Pickard Bay (site 8)	Spatial/ temporal overlap with the META project	Details	Date of Construction	Further Assessment required?	Justification
Operation and maintenance	Pembroke Dock Port on-going operations (MHPA)	2	11.3	8.8	Potential temporal overlap	Pembroke Dock port operations handles up to 62,000 Ro-Ro units per year. There is a requirement for ongoing Port activities such as maintenance dredging and repair work.	N/A	Yes	Maintenance dredging activity at Pembroke Dock Port could result in increased potential for elevated SSCs. There is therefore the potential for cumulative impacts with 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 SSCs or reduction in benthic habitats. There is therefore the potential for cumulative impacts with the META project.
Installation/ operation and maintenance	Milford Haven Port Authority - SC1810: Pembroke Dock Infrastructure	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.	Q3 2019 – Q3 2023	Yes	There will be temporal and spatial overlap of the project with the META Project and there is the potential for cumulative impacts due to increased SSCs and habitat loss/disturbance.
Installation/ operation and maintenance	Neyland Marina dredging works (Neyland Yacht Haven Ltd.) and disposal site	1.1	12.3	10.5	Potential temporal overlap	DML1743 – Dredge and disposal from Neyland Marina; no spatial overlap. Annual volume 5,500 m <sup>3</sup> .	13/12/2017-12/12/2020	Yes	Sediment plumes generated from placement of material in identified disposal ground and dredging activities may present potential cumulative impacts 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 <sup>3</sup> .	09/03/2017-08/03/2022	Yes	
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 500MW subsea electricity interconnector linking the power markets in Ireland and Great Britain and is planned for commissioning in 2023. As an EU Project of Common Interest, it is one of Europe's most important energy infrastructure projects. The interconnector is planned to make Landfall at Fresh Water West beach to the south of the mouth of the Waterway.	07/2018 - ongoing	Yes	There is the potential for cumulative impacts on benthic receptors due to increased suspended sediment and habitat loss/disturbance.

Phase	Developer - Reference	Distance (km) from Warrior Way (site 6)	Distance (km) from Dale Roads (site 7)	Distance (km) from East Pickard Bay (site 8)	Spatial/ temporal overlap with the META project	Details	Date of Construction	Further Assessment required?	Justification
Installation/ operation and maintenance/ decommissioning	Bombora Wave Energy	11.6	5.0	0	Spatial overlap with East Pickard Bay (site 8) within META test 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 <sup>2</sup> 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	Yes	There is the potential for spatial overlap in the META East Pickard Bay test area (site 8) and temporal overlap with all META project sites installation and operation and maintenance phases, therefore this project cannot be excluded from further consideration in the CIA.

## 5.10.2 Cumulative Impact Assessment

5.10.2.1 There is the potential for cumulative increases in SSCs and sediment deposition within the coastal processes study area as a result of installation/decommissioning activities associated with the META project together with construction activities associated with the Pembroke Dock Marine project, dredging and disposal activities in the Waterway, installation of a temporary marine cable and wave energy device associated with the proposed Bombora project, and the Greenlink Interconnector project. In all cases the aspect of coastal processes which may be affected is the potential increase in SSC.

### Magnitude of impact

5.10.2.2 Maintenance dredging and associated disposal activities within the Waterway have the potential to cause short term elevations in SCC. Pembroke Dock, Neyland Marina and Milford Haven all undergo such actions on an intermittent basis. Given that the increases in SSC associated with the META project only occur during the commissioning phase for Dale Roads (site 7) and East Pickard Bay (site 8) and of a very limited nature for short periods at Warrior Way (site 6) they are very unlikely to interact either temporally or spatially.

5.10.2.3 Similarly, the brevity of potentially elevated SSC during the META project makes it unlikely that it will overlap with the one-off capital dredging works for the Pembroke Dock redevelopment Project. Given that works are anticipated to be within the footprint of the new slipway and Graving Dock and that dredging works will be temporary and short lived, it is considered unlikely that there would be any cumulative impacts. The Pembroke Dock Infrastructure project also incorporates Phase 1 activities in the META scheme; no impacts from the Phase 2 activities extend into the Phase 1 areas and Phase 1 activities (by definition) have no impact beyond the immediate location. Therefore, no cumulative effects are considered likely to occur from the two schemes due to concurrent activity.

5.10.2.4 The Greenlink Interconnector project outlines ploughing and trenching operations to install the cable and the placement of cable protection material on the seabed (Intertek, 2016). This may cause very localised increases in SCC for short durations and are unlikely to interact with the META project.

5.10.2.5 Cable installation works for the temporary marine cable associated with the Bombora project are of short duration (up to 3 days marine cable installation works), and there will be minimal disturbance of sediment as the cable will be laid on the seabed within the East Pickard Bay (site 8) META site and kept in place using clamshell weights, and will be laid along a naturally occurring rock channel out with the META site. This may cause very localised increases in SCC for short durations and is considered unlikely to interact with the META project.

5.10.2.6 Cumulative impacts are therefore predicted to be unlikely and if they occur of a temporary and short-term nature. The magnitudes of cumulative impacts are therefore considered to be minor.

## 5.11 Transboundary effects

5.11.1.1 All effects identified during the course of the Coastal Processes impact assessment have been minor in nature and limited to the immediate vicinity of the three META project sites under consideration. Therefore, there is no potential for significant transboundary effects with regard to coastal processes from the META project upon the interests of other EEA States.

## 5.12 Conclusion and summary

5.12.1.1 The impact of a range of activities was investigated for each of the three META project sites namely Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8).

5.12.1.2 The Warrior Way (site 6) tidal site may experience temporary increases in suspended sediment concentration during the installation phase. Minor changes may be seen in bed transport in close proximity to the gravity base included in the maximum design scenario, as summarised in Table 5.5. There will be no change to the hydrodynamic regime due to the installation of scaled/micro tidal devices at Warrior Way (site 6). The most likely scenario does not require a gravity base and seabed disturbance is much reduced. Deployment at this site is temporary for a maximum of 6 months and any effects would be transitory.

5.12.1.3 The Dale Roads wave energy site (site 7) may experience temporary increases in suspended sediment concentration during the installation phase should the maximum design scenario be implemented. These would be reduced for the smaller provision required under the most likely scenario. All impacts as summarised in Table 5.6 would be transitory and following decommissioning after a maximum period of 12 months, coastal processes would return to those experienced prior to device testing.

5.12.1.4 East Pickard Bay (site 8) would be used for the largest full-scale wave devices and floating offshore wind component testing. However only minor changes may be seen in bed transport due to the open bay location and device alignment. These impacts are summarised in Table 5.7. The largest wave device considered may reduce the incident wave energy by less than 1% along the shoreline, and the wave climate is restored to uniformity prior to reaching the intertidal zone, even for the largest waves. As with the other sites, deployment is temporary for a maximum of 18 months and any effects would be transitory and wave climate and sediment transport would return to previous levels.

5.12.1.5 In conclusion, due to the limited number and size of devices and the temporary nature of deployment proposed at the META project, the impacts of the META project activities at one or all three sites combined would be minor and not significant in EIA terms.

Table 5.5: Summary of potential environment effects, mitigation and monitoring Warrior Way (site 6).

Description of impact	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
<b>Installation and decommissioning phases</b>						
Increases in SSC and deposition of disturbed sediments to the seabed	N/A	Minor	N/A	N/A	N/A	N/A
Release of contamination adsorbed to sediments disturbed on ecological receptors	N/A	Minor	N/A	N/A	N/A	N/A
<b>Operation and maintenance phase</b>						
Increases in SSC and deposition of disturbed sediment to the seabed	N/A	Minor	N/A	N/A	N/A	N/A
Changes to the hydrodynamic regime due to operation of tidal turbines	Tidal device	Minor	Low	Minor (not significant in EIA terms)	None	N/A
Impacts to sediment transport and sediment transport pathways	Gravity base	Minor	Low	Minor (not significant in EIA terms)	None	N/A

Table 5.6: Summary of potential environment effects, mitigation and monitoring Dale Roads (site 7).

Description of impact	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
<b>Installation and decommissioning phases</b>						
Increases in SSC and deposition of disturbed sediments to the seabed	N/A	Minor	N/A N/A	N/A	N/A	N/A
Release of contamination adsorbed to sediments disturbed on ecological receptors	N/A	Minor	N/A N/A	N/A	N/A	N/A
<b>Operation and maintenance phase</b>						
Changes to the wave regime, with associated impacts on adjacent coastlines	Minor	Low	Minor (not significant in EIA terms)	None	N/A	None
Scour of seabed sediments	Minor	Low	Minor (not significant in EIA terms)	Device-specific desktop scour assessment	N/A	None
Impacts to sediment transport and sediment transport pathways	Minor	Low	Minor (not significant in EIA terms)	None	N/A	None

Table 5.7: Summary of potential environment effects, mitigation and monitoring East Pickard Bay (site 8).

Description of impact	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
<b>Installation and decommissioning phases</b>						
Increases in SSC and deposition of disturbed sediments to the seabed	N/A	Minor	N/A	N/A	N/A	N/A
Release of contamination adsorbed to sediments disturbed on ecological receptors	N/A	Negligible	N/A	N/A	N/A	N/A
<b>Operation and maintenance phase</b>						
Changes to the wave regime, with associated impacts on adjacent coastlines	Minor	Low	Minor (not significant in EIA terms)	None	N/A	None
Scour of seabed sediments	Minor	Low	Minor (not significant in EIA terms)	Device-specific desktop scour assessment	N/A	None
Impacts to sediment transport and sediment transport pathways	Minor	Low	Minor (not significant in EIA terms)	None	N/A	None

## 5.13 References

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