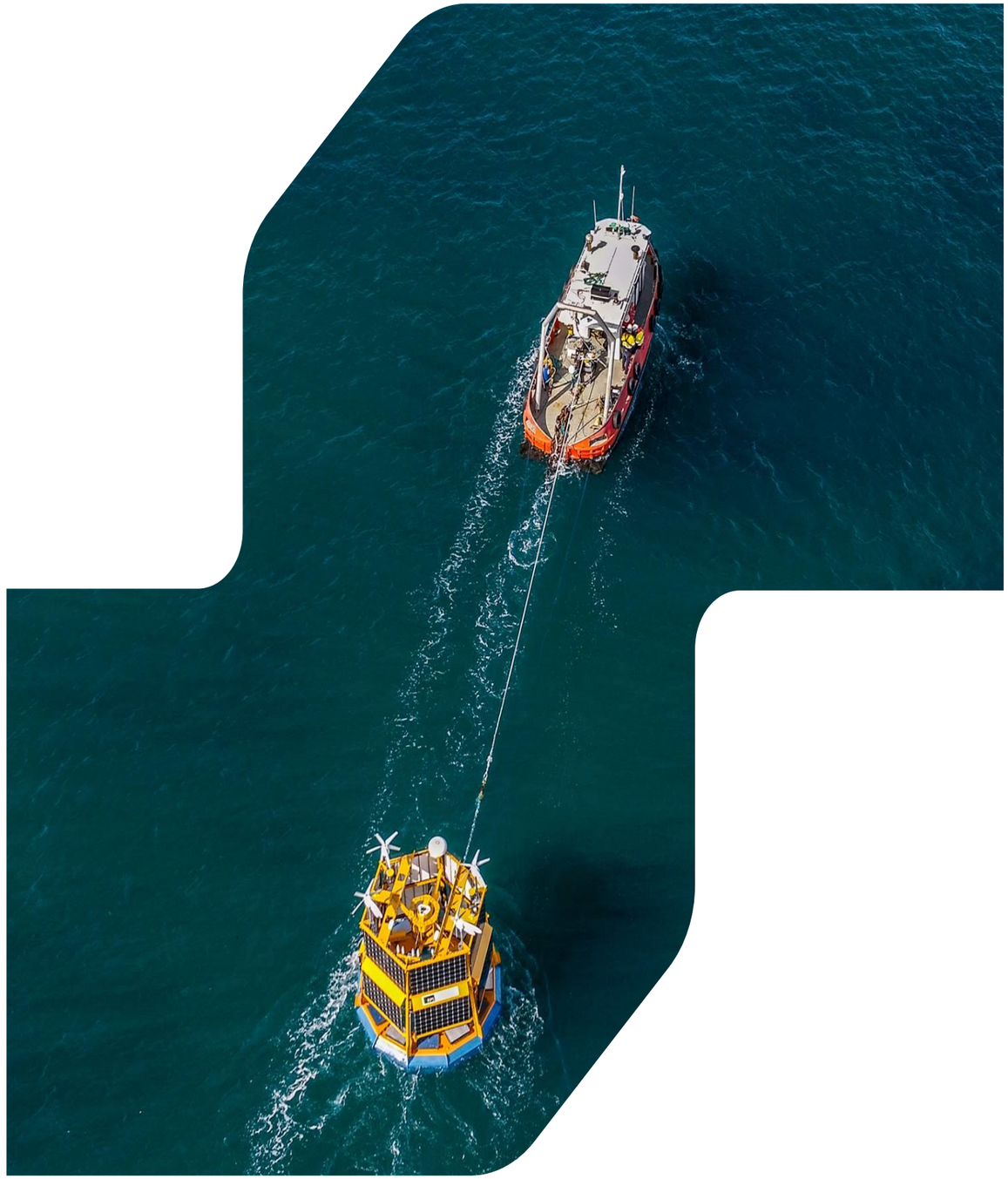
MARINE ENERGY WALES

MARINE ENERGY TEST AREA (META)

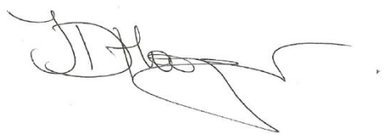
Invasive Non-Native Species Management Plan



EOR0730
Marine Energy Test Area
Rev: 02
December 10, 2019

rpsgroup.com

Document status					
Version	**Purpose of document**	**Authored by**	**Reviewed by**	**Approved by**	**Review date**
Rev00	Internal Draft	Adam Crowther	Ruth De Silva		17/07/19
Rev01	Client Review	Adam Crowther	Ruth De Silva	RDS	31/07/19
Rev02	Final Version	Adam Crowther	Jessica Hooper	Jessica Hooper	10/12/19

Approval for issue		
Jessica Hooper		10 December 2019

Prepared by:

RPS Energy Ltd.

Prepared for:

Marine Energy Wales

Table of Contents

Table of Figures

Table of Tables

1 INTRODUCTION

1.1 Background

1.1.1.1 This biosecurity plan has been prepared by RPS for Marine Energy Wales (MEW), a Pembrokeshire Coastal Forum (PCF) Community Interest Company (CIC) led project (the Applicant) in relation to the META project (phases 1 and 2), with regard to the installation, operation and maintenance, and decommissioning of marine renewable devices and ancillary equipment within Milford Haven and adjacent waters, in Pembrokeshire, Wales.

1.1.1.2 The Marine Energy Test Areas project (the META project) will provide marine renewable energy device developers with pre-consented testing sites, which will reduce the consenting burden on device developers. The aim of the META project is therefore to provide a series of pre-consented, non-grid connected, marine energy test areas that will allow for the deployment and testing of devices, components and subassemblies, and ancillary activities and equipment, in support of marine energy testing. Thereby de-risking marine energy projects prior to larger scale or array deployments.

1.1.1.3 A total of eight areas were identified as suitable META project sites by MEW, these are Carr Jetty (site 1), Mainstay Quay (site 2), Ferryside (site 3), Quay 1 (site 4), Criterion Jetty (site 5), Warrior Way (site 6), Dale Roads (site 7) and East Pickard Bay (site 8). Sites 1 - 5 are located in close proximity (< 1000 m) to Pembroke Dock, sites 6 – 7 are located within the Waterway, and East Pickard Bay (site 8) is located south east of the Waterway (Figure 1.1). These sites are located in a waterbody with known invasive non-native species (INNS) and will require an Invasive Non-Native Species Management Plan (INNSMP) to reduce the likelihood of introduction and spread of these species (NBN Gateway, data obtained in May 2019).

1.1.1.4 Many INNS, including the slipper limpet *Crepidula fornicata*, *Pacific oyster Crassostrea gigas*, soft shelled clam *Mya arenaria*, oyster thief *Colpomenia peregrina* and Darwin's barnacle *Austrominius modestus* have been recorded throughout the Waterway (NBN Gateway, data obtained in May 2019). This INNSMP assesses the risk of introduction and spread of INNS associated with the META project and to present appropriate measures to minimise these risks as much as possible following best guidance (Cook *et al*. 2014). This document should be read in conjunction with the META 'Environmental Appraisal Phase 1 sites' document, supporting the Band 2 ML (DEML187) and the META Environmental Statement, supporting the Band 3 ML application.

1.1.1.5 A biosecurity plan overview has been provided in Table 1.1.

Table 1.1: Biosecurity plan overview.

Development Activity	META project detail
Description of Operation:	Testing, including deployment, installation, operation and maintenance, and decommissioning of marine renewable energy devices and ancillary equipment.
Site/Operation Location:	Milford Haven Waterway, Pembrokeshire, Wales.
Plan Period:	Intermittent activity over 10 years for Phase 1 (sites 1 – 5), and over 15 years for Phase 2 (sites 6-8) commencing 2019 and 2020, respectively.
Risk:	The META Project is at risk of introducing or spreading INNS within the Milford Haven Waterway
META Operations Manager:	Responsible for ensuring compliance with all plans, licenses and conditions for the META.

1.2 Purpose of this Invasive Non-Native Species Management Plan

1.2.1.1 The EU Invasive Alien Species regulation came into force in January 2015, which requires action plans to control the introduction and spread of INNS. This regulation indirectly affects the Water Framework Directive (WFD)[1], the Wildlife and Countryside Act 1981[2] and the Marine Strategy Framework[3], ensuring compliance, follows best practice and aids in the protection of Great Britain's waters. This INNSMP ensures compliance with relevant legislation and international commitments for the META Project.

1.2.1.2 The purpose of this INNSMP is to ensure all procedures pertaining to marine device deployments and retrievals, ancillary support structures, and maintenance operations follow best guidance, preventing and reducing the risk of possible spread or introduction of INNS into the Waterway and waters beyond. The method employed follows the GB Invasive Non-Native Species Framework Strategy which has a three-tier approach (GB NNSS, 2008):

- Prevention: Prevent all INNS from entering the waterbody in question;
- Rapid response: Detection of INNS as early as possible, monitor and possible eradication INNS present;
- Control and containment: Should proliferation of INNS be too great for eradication, control and containment of populations will be required.

1.2.1.3 This INNSMP focuses on "Prevention", in line with the INNS Framework Strategy, with a view to avoiding 'rapid response' and 'control and containment' methods. Furthermore, this document is to remain 'live', with periodic updates by the META Operation & Environment Manager as outlined within Section 4.7 (Evaluation and Review).

1.2.1.4 This report is set out as follows:

- Section 2: Summary of the META project description;
- Section 3: Summary of INNSMP methodology;
- Section 4: The META INNSMP; and
- Section 5: Useful sources of information for META project management.

[1] The WFD requires all European member states to aim for good chemical and ecological status (ecological status takes into account INNS present, which can reduce a waterbodies status).

[2] It is illegal under section 14 of the Wildlife and Countryside Act 1981 (as amended) to release or allow to escape into the wild any animal which is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state or is listed in Schedule 9 to the Act.

[3] The Marine Strategy Framework Directive requires Member States to put in place measures to achieve good environmental status in their marine waters by 2020.

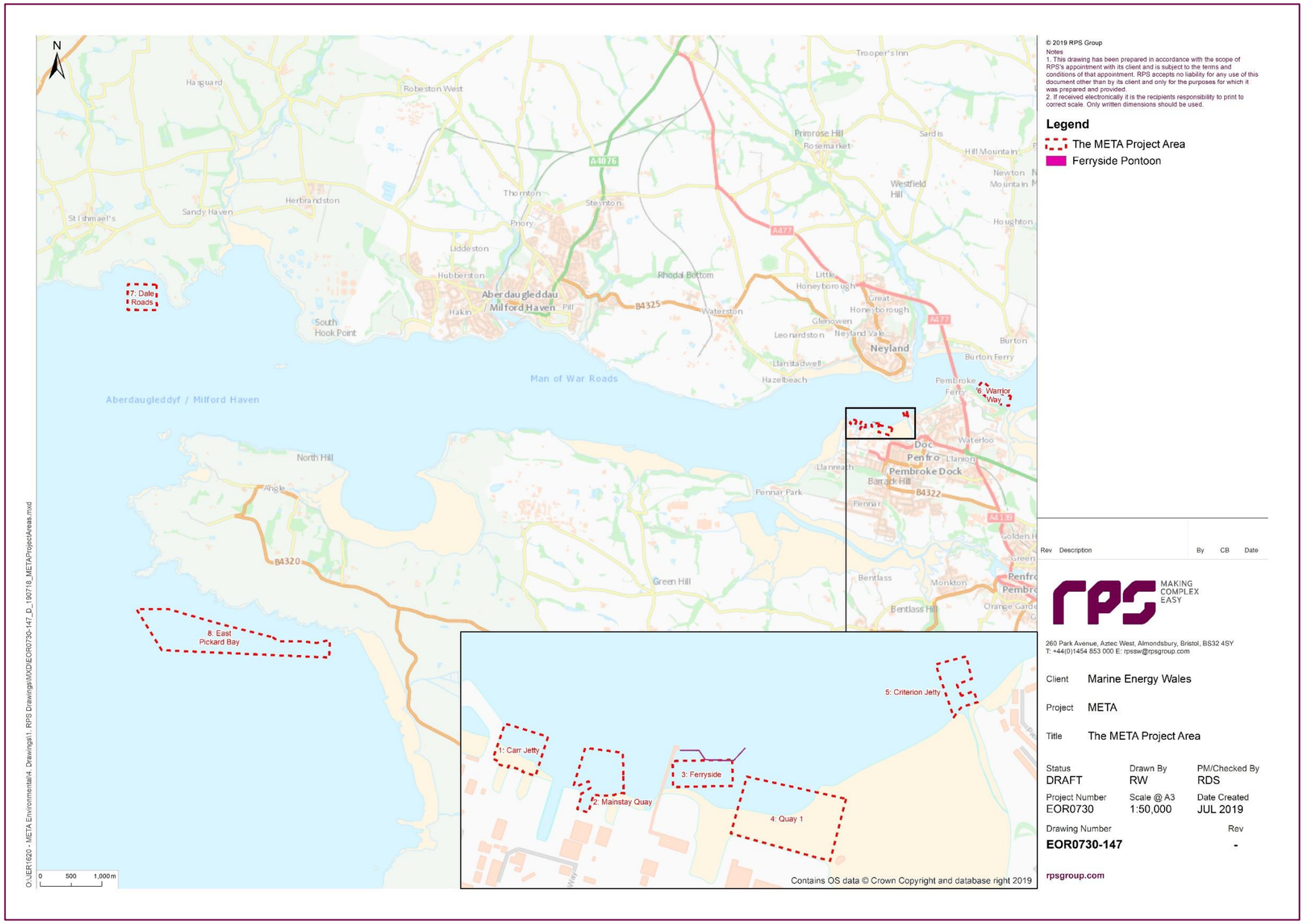


Figure 1.1: Location of the META sites.

2 PROJECT DESCRIPTION

2.1 Overview

2.1.1.1 The proposed META project forms part of Pembroke Dock Marine, a £76 million project to develop a world class centre for marine energy development, fabrication, testing and deployment, in Pembrokeshire[4]. This is one of 11 projects included in the Swansea Bay City Deal signed in 2017. The four pillars of the Pembrokeshire Dock Marine Project include:

- The META Project;
- Marine Energy Engineering Centre of Excellence (MEECE);
- Pembroke Dock Infrastructure; and
- Pembrokeshire Demonstration Zone (PDZ).

2.2 Site Locations

2.2.1 Carr Jetty (site 1)

2.2.1.1 Carr Jetty (site 1) encompasses the eastern side of Carr Jetty within Pembroke Dockyard and the waters to the east of it. It is located to the north of the dry dock and west of the ferry terminal. The site offers a water depth of between -3 m CD and - 4 m CD (Chart Datum) with a sheltered tidal resource (approx. 1.7 knots (Tidal Atlas)), in an accessible environment. Carr Jetty (site 1) encompasses an area of 7,100 m^2 (0.71 Ha).

2.2.1.2 Figure 2.1 illustrates the location and extent of Carr Jetty (site 1) in relation to environmental designated sites.

2.2.2 Mainstay Quay (site 2)

2.2.2.1 Mainstay Quay (site 2) lies within Pembroke dockyard immediately to the west of the ferry port and adjacent to existing quayside operations at Mainstay Quay. Mainstay Quay (site 2) has mild wave conditions and is dredged to a depth of between - 3.9 m CD and - 5.0 m CD. The site encompasses an area of 8,700 m^2 (0.87 Ha). Figure 2.2 illustrates the location and extent of Mainstay Quay (site 2) in relation to environmental designated sites.

2.2.3 Ferryside (site 3)

2.2.3.1 Ferryside (site 3) lies within Pembroke dockyard immediately to the south of the Pembroke Dock-Rosslare ferry pier and Ro-Ro berth, and immediately north-east of Quay 1 (site 4). Ferryside displays mild wave conditions and has a water depth between - 2 m CD and - 5 m CD. The site encompasses an area of 5,900 m^2 (0.59 Ha).Figure 2.2 illustrates the location and extent of Quay 1 (site 4) in relation to environmental designated sites.

2.2.4 Quay 1 (site 4)

2.2.4.1 Quay 1 (site 4) lies within Pembroke Dockyard to the east of the ferry port and adjacent to Ferryside (site 3). This area is actively used as part of the Pembroke Dockyard operations and is in use for general cargo/offloading. The quayside accommodates vessels up to 164 m in length and has a 6.8 m control depth. Water depth on site is between - 6.8 m CD to - 8 m CD. The site encompasses an area of 23,900 m^2 (2.39 Ha).Figure 2.2 illustrates the location and extent of Quay 1 (site 4) in relation to environmental designated sites.

2.2.5 Criterion Jetty (site 5)

2.2.5.1 Criterion Jetty (site 5) is an area of reasonable tidal flow adjacent to the existing, but not currently operational, criterion jetty, which is to the east of Pembroke Dockyard. Milford Haven Port Authority (MHPA) is considering reinstating this jetty for operation activities to expand current Port facilities. Criterion Jetty (site 5) offers a tidal flow of between 0.3 m/s and 0.6 m/s during peak spring tidal conditions, however, access is only via vessels as onshore health and safety concerns limit access by land. Water depth on site is between - 13.3 m CD to - 7.4 m CD. The site encompasses an intertidal area of 4,800 m^2 (0.48 Ha) below MLWS (mean low water spring).Figure 2.2 illustrates the location and extent of Criterion Jetty (site 1) in relation to environmental designated sites.

2.2.6 Warrior Way (site 6)

2.2.6.1 Warrior Way (site 6) 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. Warrior Way (site 6) encompasses an area of 93,000 m^2 (9.3 Ha) and lies entirely within the Pembrokeshire Marine Special Area of Conservation (SAC), in close proximity to habitats identified as “Nationally Important Intertidal Habitats”, and immediately adjacent to the Milford Haven Waterway Site of Special Scientific Interest (SSSI). Figure 2.2 illustrates the location and extent of Warrior Way (site 6) in relation to environmental designated sites.

2.2.7 Dale Roads (site 7)

2.2.7.1 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 is characterised by water 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^2

[4] For further information on Pembroke Dock Marine projects, visit: http://www.marineenergywales.co.uk/marine-energy-in-wales/projects/pembroke-dock-marine/

(19.56 Ha) and lies entirely within the Pembrokeshire Marine SAC and the West Wales Marine SAC. The coast at Dale Roads (site 7) is part of the Milford Haven Waterway SSSI.

2.2.7.2 Figure 2.3 illustrates the location and extent of the Dale Roads (site 7) in relation to environmentally designated sites. Dale Roads (site 7) benefits from good access and has previously supported wave device developer testing (e.g. wavetricity).

2.2.8 East Pickard Bay (site 8)

2.2.8.1 East Pickard Bay (site 8) lies immediately south of Sheep Island and runs south-eastward parallel to the coast towards Freshwater West bay. The 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. East Pickard Bay (site 8) encompasses an area of 1,230,000 m^2 (123 Ha) and lies entirely within the Pembrokeshire Marine SAC and the West Wales Marine SAC. Castlemartin Coast Special Protection Area (SPA) lies inland to the north east of East Pickard Bay (site 8). The site also lies adjacent to a Ministry of Defence (MOD) Danger Area.

2.2.8.2 Figure 2.4 illustrates the location and extent of East Pickard Bay (site 8) META marine testing site in relation to the surrounding area and designated sites.

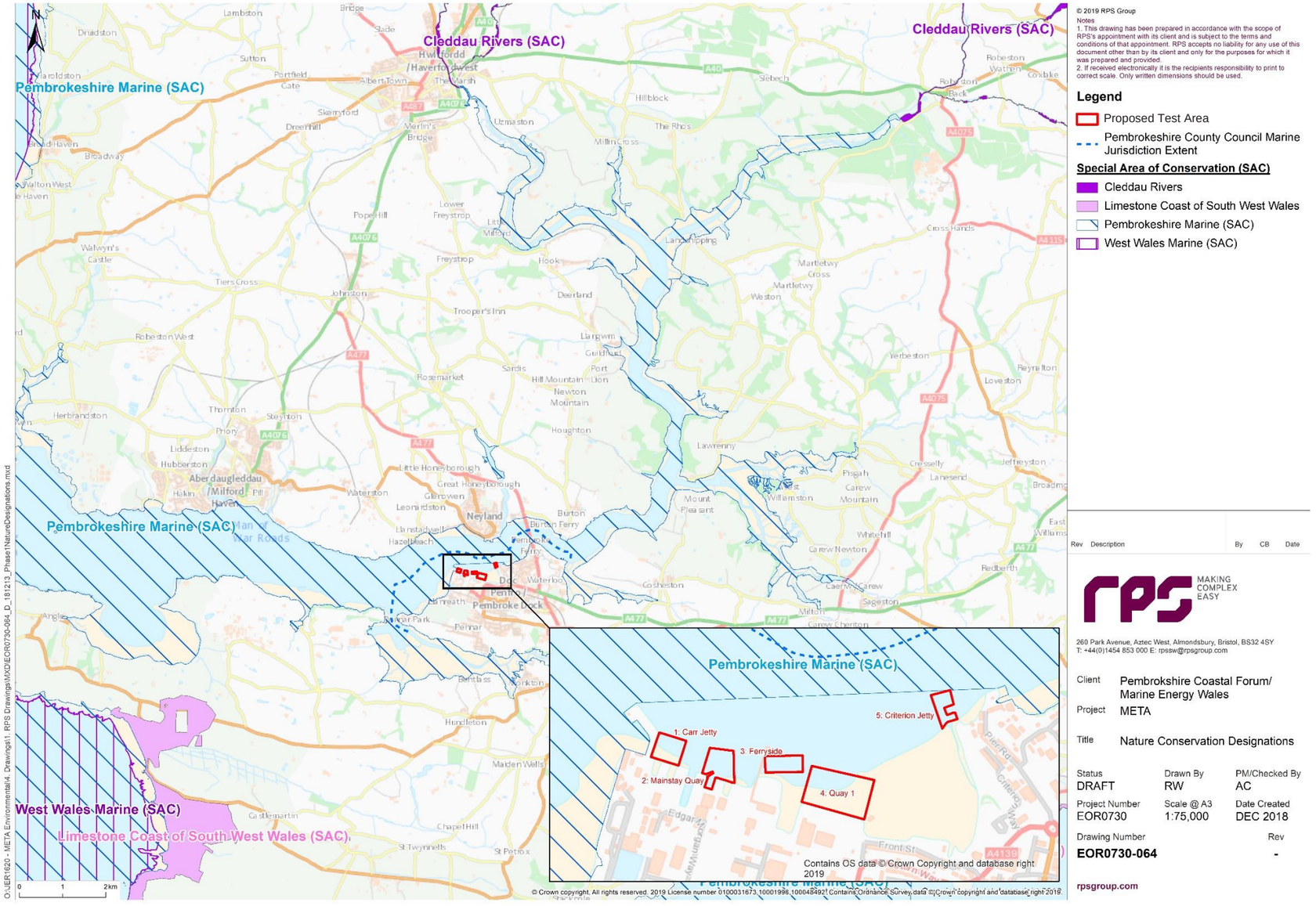


Figure 2.1: Location of sites 1 -5. Note: All sites lie out-with any designated sites.

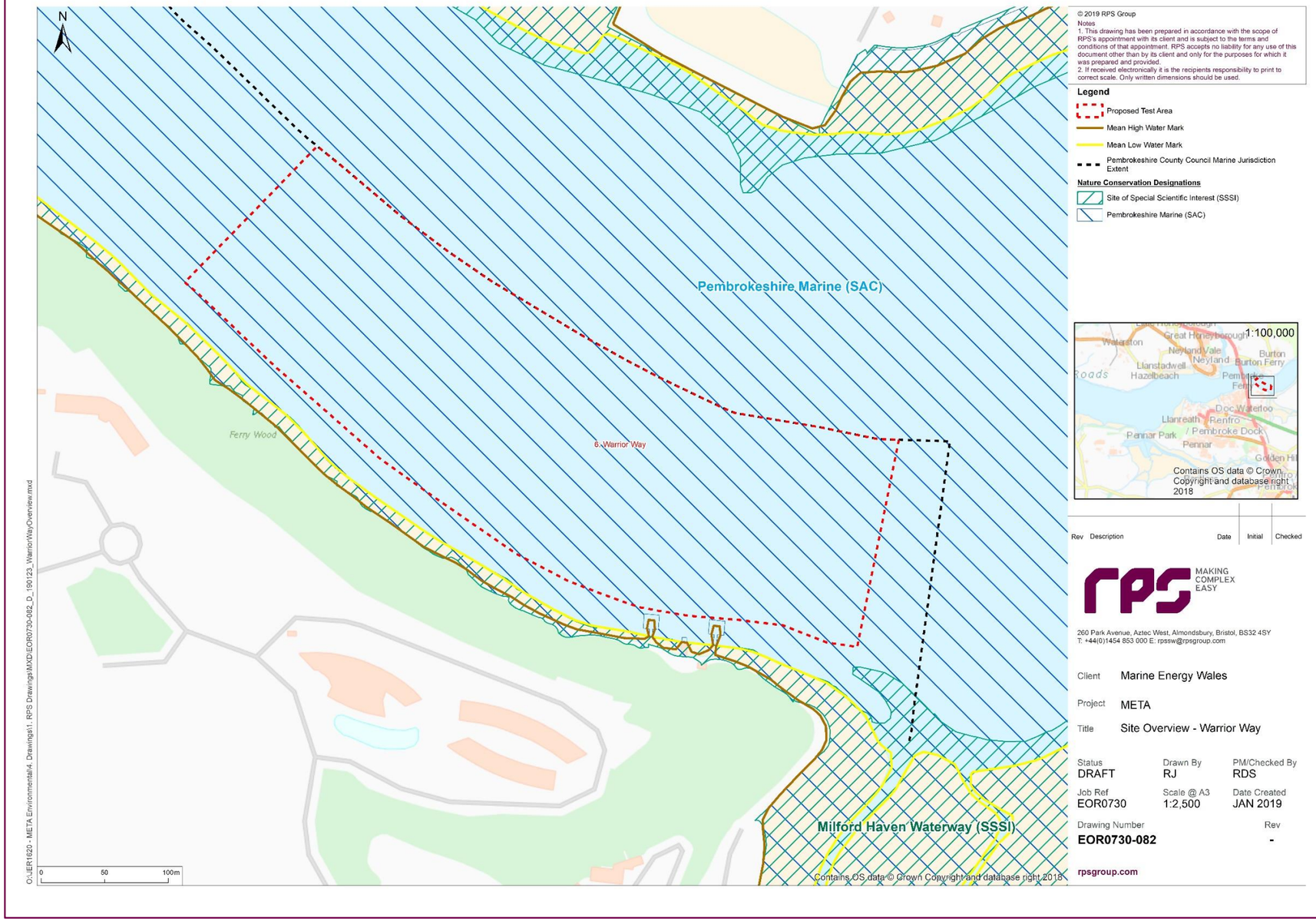


Figure 2.2: Location of Warrior Way (site 6).

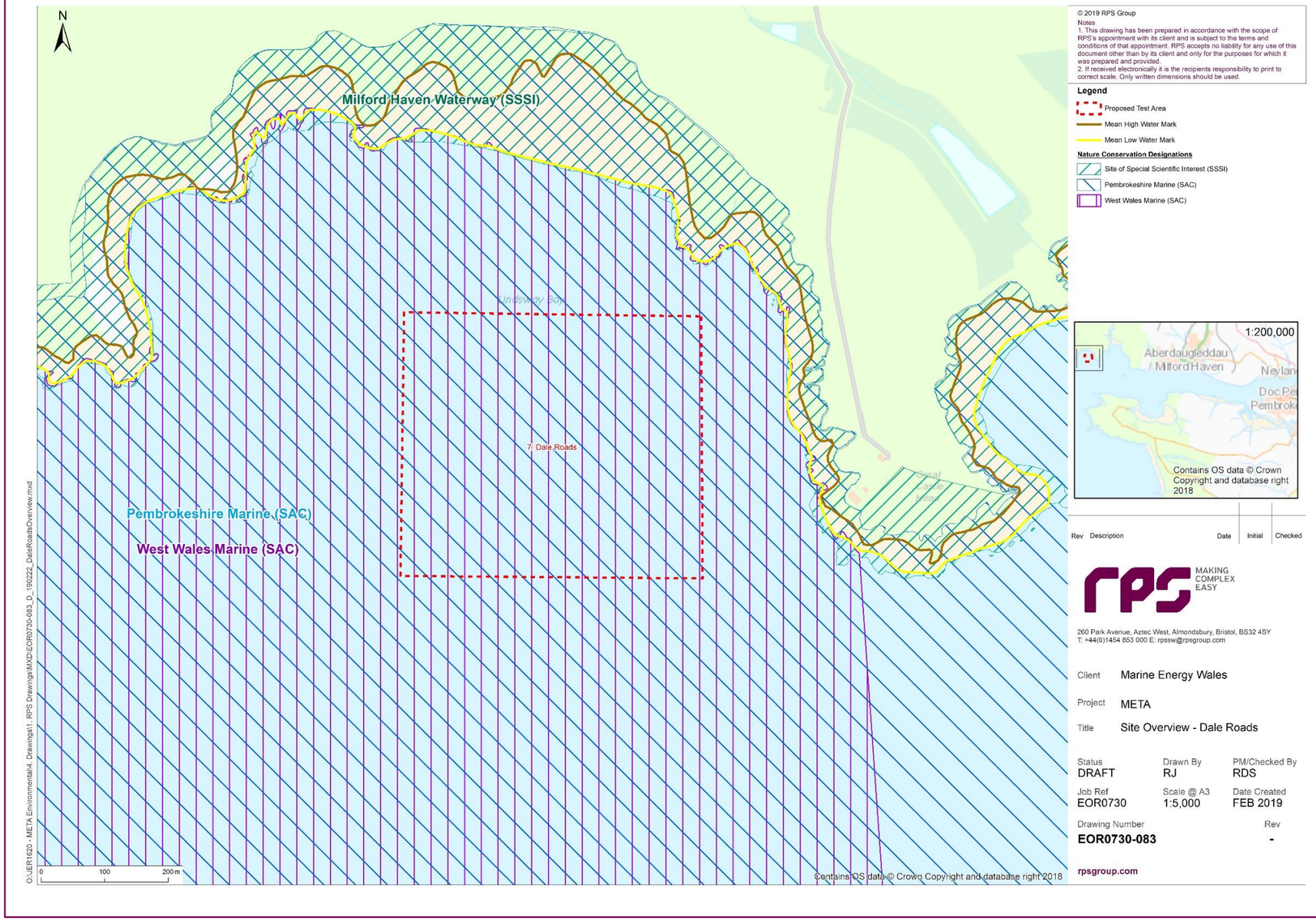


Figure 2.3: Location of Dale Roads (site 7).

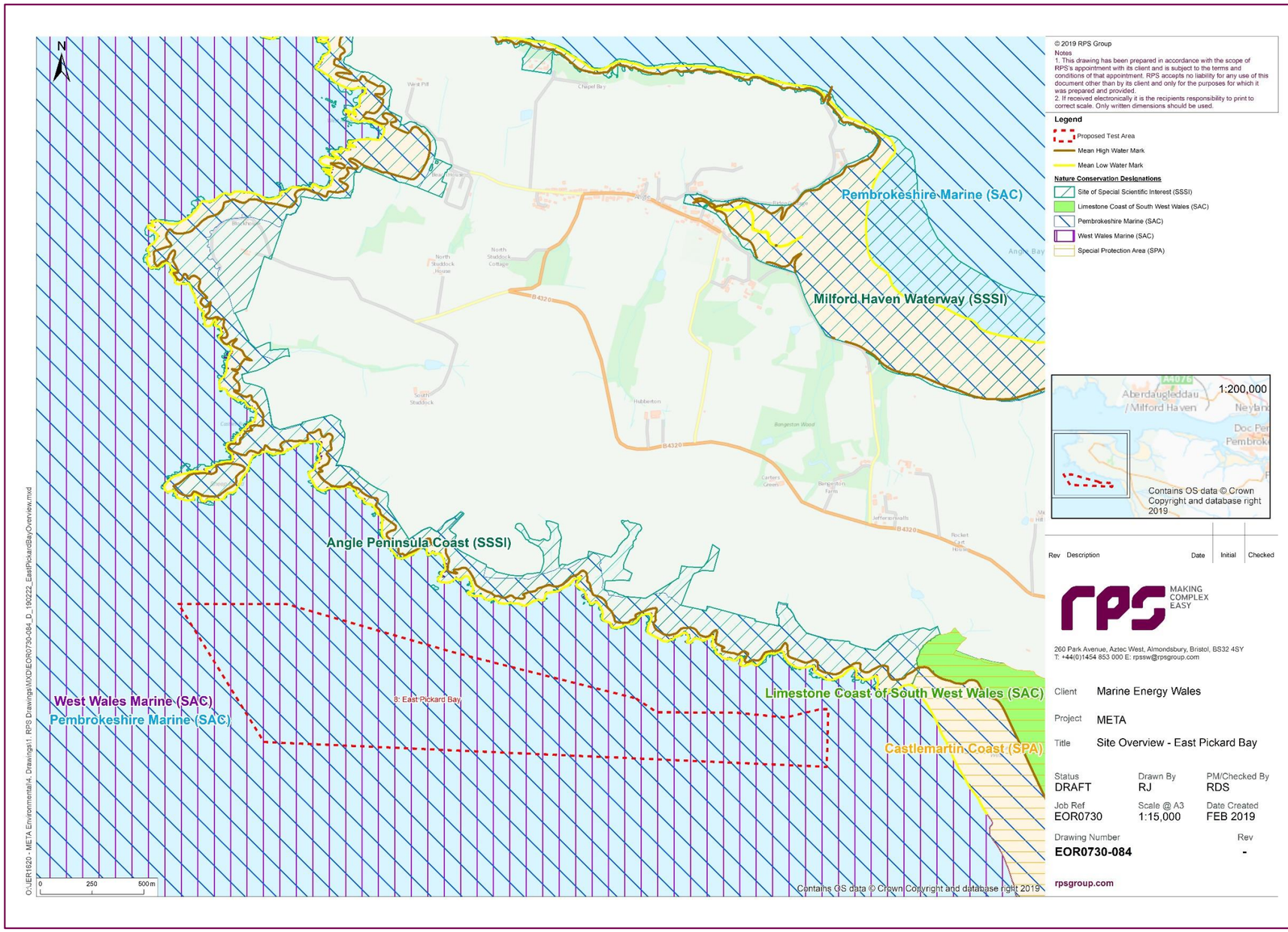


Figure 2.4: Location of East Pickard Bay (site 8).

2.3 Marine Works

2.3.1.1 Works proposed are to include components, sub-assemblies, scaled and full-scale marine energy devices, testing of which will not be grid-connected. Marine energy devices are likely to be deployed and retrieved over the lifespan of the project, 10 years for Phase 1 (sites 1 – 5) and 15 years for Phase 2 (sites 6 – 8), with operation and maintenance occurring subject to device requirements.

2.3.1.2 Access to sites 1 - 5 will be via existing infrastructure such as jetties or quayside, or deployed from developers' own moorings, platforms, or vessels from Pembroke Port. Vessels used for deployment, retrieval, and operations and maintenance for site 1 - 5 will have a maximum length of 35 m, and a maximum draught of 6.8 m.

2.3.1.3 Access to Warrior Way (site 6) and Dale Roads (site 7) will be by vessel from Pembroke Port. Vessels used for deployment, retrieval and operations and maintenance at Warrior Way (site 6) have a maximum length of 35 m, and a maximum draught of 6.8 m. Vessels used for deployment, retrieval and operations and maintenance at Dale Roads (site 7) will have a maximum length of 164 m, and a maximum draught of 6.8 m which is dictated by the maximum vessel length and draught that can be supported at Pembroke Port. Access to the East Pickard Bay (site 8) will be from local ports. Vessels accessing this META project site will have a maximum length of 200 m, and a maximum draught of 8 m. This is dictated by the maximum vessel length and draught that can be supported at local ports (Wales).

2.3.2 Phase 1 (sites 1 – 5)

2.3.2.1 These sites will enable the testing of:

- Dip testing of subassemblies, components, monitoring and research equipment;
- Short duration dip testing of full-scale devices;
- Testing of deployment and retrieval methodologies of subassemblies, components, monitoring and research equipment;
- Testing of vessel approach and recovery methodologies;
- Testing of H&S procedures; and
- Operational testing of instruments, components and subassemblies, monitoring and research equipment.

2.3.2.2 Carr Jetty (site 1) and Criterion Jetty (site 5) will support the testing of one marine energy device occurring at any one time within the test area. Marinstay Quay (site 2), Ferryside (site 3) and Quay 1 (site 4) will support the testing of up to two marine energy devices at any one time.

2.3.2.3 A floating pontoon will be installed adjacent to Ferryside (site 3) to support the testing of marine energy devices. Four pontoons are to be fabricated on land, slipped and towed into final position in 2-3 days. The floating pontoons will be tethered to the existing dolphins. Pontoon will be in-situ all year round with removals for maintenance every five years.

2.3.2.4 Criterion Jetty (site 5) will only support the testing of vessel approach and recovery methodologies.

2.3.2.5 Testing activities may be in support of either wave or tidal deployments as well as research and monitoring equipment but will not include the operational testing of wave and tidal devices. Instrument, component and subassembly testing may include floating surface structures, surface piercing structures, and sub-surface testing. MEW will provide navigational marker buoys and Acoustic Doppler Current Profilers (ADCPs) as required to support testing activities at sites enabling testing activities.

2.3.2.6 Testing activities may occur concurrently at sites 1 - 5, and some sites may also support more than one testing activity at any one time. It is more likely however, that each site will support only single activity testing at any one time.

2.3.3 Phase 2 (sites 6 - 8)

2.3.3.1 Sites 6-8 will enable testing of:

- Scaled wave device testing;
- Scaled tidal device testing;
- Full scale wave device testing;
- Micro-scale tidal device testing;
- Testing of remotely operated vehicle (ROV) or other monitoring equipment;
- Site preparation methodologies;
- Decommissioning methodologies;
- Salvage methodologies; and
- Tow, float and mooring solution testing for floating offshore wind technology.

Warrior Way (site 6)

2.3.3.2 Warrior Way (site 6) will support the testing of one marine energy device occurring at any one time within the test area (maximum and most likely scenario) and enable the testing of:

- Scaled tidal devices,
- Micro tidal devices,
- Instruments, components and subassemblies;
- ROV or other monitoring equipment;
- Site preparation methodologies;
- Decommissioning methodologies; and
- Salvage methodologies.

2.3.3.3 The marine energy device will be towed to site and installed on pre-prepared foundations, mooring, deployed to the seabed, or deployed from a floating platform or test support buoy. Marine energy devices at Warrior Way (site 6) will be demarked by up to four navigational marker buoys.

Dale Roads (site 7)

2.3.3.4 Dale Roads (site 7) will support the testing of one marine energy device occurring at any one time within the test area (maximum and most likely scenario) and enable the testing of:

- Scaled wave energy converter (WEC) devices;
- Full-scale WEC devices; and
- Research and monitoring methodologies.

2.3.3.5 The marine energy device will be towed to site and installed on pre-prepared foundations, mooring, deployed to the seabed, or deployed from a floating platform or test support buoy. The marine energy device at Dale Roads (site 7) will be demarked by up to four navigational marker buoys. A test-support buoy capable of dissipating energy at site may be provided but does not require the installation of any permanent infrastructure.

2.3.3.6 Drilled pin pilling may be required to support test deployment. The maximum diameter of the pin piles to be installed will be 100 mm. Piles will be drilled only, to between 10 m and 20 m below the sea bed.

East Pickard Bay (site 8)

2.3.3.7 East Pickard Bay (site 8) will support the testing of two marine energy devices for the maximum scenario and one marine energy device for the most likely scenario occurring at any one time and will enable the testing of:

- Full-scale WEC device testing;
- Scaled WEC device testing; and
- Component testing for floating offshore wind technology.

2.3.3.8 The marine energy devices will be towed to site and installed on pre-prepared foundations, with moorings, directly onto the seabed, on a floating platform, and/or associated with a test support buoy. The marine energy devices at East Pickard Bay (site 8) will be demarked by up to four navigational marker buoys. A test-support buoy capable of dissipating energy at site may be provided but does not require the installation of any permanent infrastructure.

2.3.3.9 Drilled pin pilling may be required to support test deployment. The maximum diameter of the pin piles to be installed will be 100 mm. Piles will be drilled only, to between 10 m and 20 m below the sea bed.

2.3.3.10 In addition to the pin pilling, marine energy devices may require the use of rock ballasting for scour protection/moorings. The rocks will be contained in bags and will be removed/ left in-situ at the end of the marine energy device testing period (dependent on least impact to environment). Each rock bag may contain up to five tonnes of rock and may have a diameter of 2 m. For the most likely scenario this would represent 100 bags, equivalent to 500 tonnes, taking up to five days to deploy this volume of rock.

2.4 Timescales

2.4.1.1 It is anticipated that first test deployments at META project sites will commence in 2019 for Phase 1 (sites 1 – 5) and in 2020 for Phase 2 (sites 6 – 8), with the overall lifespan of the project being approximately 10 years for Phase 1 (sites 1 – 5) and 15 years for Phase 2 (sites 6 – 8).

3 INVASIVE NON-NATIVE SPECIES MANAGEMENT PLAN METHODOLGY

3.1.1.1 This section outlines the process of creating an INNSMP using the best available evidence available and following best practice guidance (Cook *et al.,* 2015). In order to make and accurate risk assessment of the META project and derive a suitable INNSMP, a stepwise approach was take as outlined in Figure 3.1 and discussed in detail below:

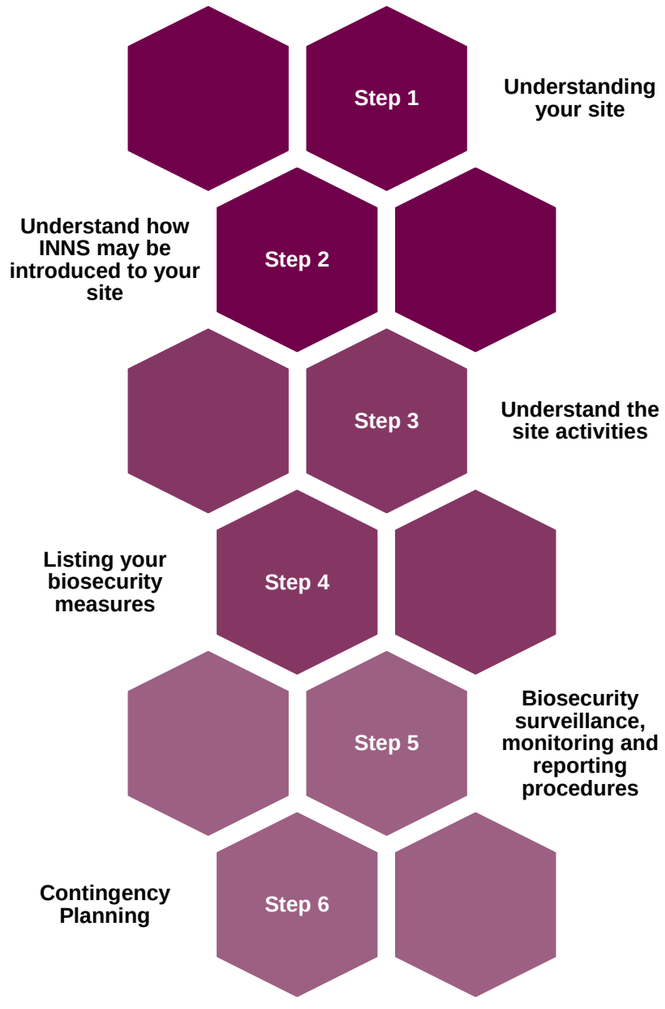


Figure 3.1: Six steps used to derive an INNSMP for the META project (Cook et al. 2015).

3.2 Step 1: Understanding your site

3.2.1.1 The first step in creating an INNSMP is to provide a detailed description of the site. This information should include the salinity of the site, any man-made structures and if INNS are present within/on site.

3.2.1.2 Understanding the salinity of the site will determine if INNS are present. The majority of marine flora and fauna are unable to tolerate freshwater due to osmoregulatory effects leading to death (Evans, 1980). The more freshwater flowing into site will result in less hospitable conditions, decrease the risk of INNS on site; conversely a fully marine site represents a greater risk.

3.2.1.3 The presence of artificial structures increases the risk of INNS establishment, even if the structure has only been present for just a few weeks as INNS are quick to establish populations. Information related to any slow or stationary periods of works or climatic conditions that may increase biosecurity risk should be included.

3.2.1.4 If INNS have been found onsite then the INNSMP should focus on reducing the risk of introducing new INNS and consider how to prevent the spread of existing INNS to other sites. Here the precautionary principle should be followed, even if no INNS are present on site.

3.2.1.5 Using this information, a site can be assessed as having **low risk** or a **significant risk** of introducing or spreading INNS. For example (Table 3.1):

Table 3.1: Example of low and significant risk sites (Cook *et al.*, 2015)

Low Risk Site	Significant Risk Site
• Supply of freshwater from a local river • Isolated from surrounding environments by walls or breakwaters i.e. closed or semi-enclosed area with little to no flow of water. • Anti-fouling used on artificial structures with periodic removal for air-drying.	• Full salinity with no freshwater inflow • Artificial structure has no antifouling coating with no management in place for maintenance • Site has connectivity to similar environments

3.3 Step 2: Understand how INNS may be introduced or spread to your site

3.3.1.1 In addition to understanding the site, consideration of pathways by which INNS may be introduced or spread are needed. The step should be iterative and revisited when the INNSMP is due for review. The following questions and associated risk have been adapted from Cook *et al.* (2015) and provide the type of questions to consider when creating an INNSMP (Table 3.2):

Table 3.2: Example questions and risk to consider whilst creating an INNSMP (from Cook *et al.*, 2015).

Questions	Yes = High	Yes = Medium	Yes = Low
1. Has the vessel/ equipment just arrived from the local area?			
2. Has the vessel/ equipment had an anti-fouling coating applied to submerged structures within the last 12 months (or time recommended by manufacturer)?			
3. Are all the visible submerged surfaces free of bio-fouling (a green 'slime' is OK)?			
4. Do the visible submerged surfaces have more than a green 'slime' coating?			
5. Does the vessel/ equipment have noticeable clumps of algae and/ or animals clinging to the visible parts?			
6. Has the vessel/ equipment just arrived from another country or region with similar environmental conditions (e.g., seawater temperature)?			
7. Has the vessel/ equipment just arrived from a water body known to have INNS present?			
8. Does the vessel/ equipment spend long periods of time stationary at sites in between anti-fouling treatments?			
9. Is the vessel 'slow moving', such as a construction barge or drilling rig?			

3.3.1.2 For example, a recreational vessel showing no signs of biofouling on the hull or below the waterline would be considered a **low risk** for introduction of INNS; conversely a work vessel/barge that moves from site to site and is present on site for long periods of time may have a **medium – high risk (i.e. significant risk)** of introducing INNS to site. For the purposes of this assessment any activity that falls within the 'Low' category in Table 3.2 above is assessed as 'Low' Risk. Any activity that falls within the 'Medium' or 'High' categories is assessed as 'Significant' Risk. This is considered to present a conservative approach to assessing risk of introducing INNS.

3.4 Step 3: Understand the site activities

3.4.1.1 Often this step involves a simple approach of listing all activities, using information obtained through the first two steps, which may carry a **significant risk** of introducing or spreading INNS. Once this list has been created, the next step is to develop control measures.

3.5 Step 4: Biosecurity control measures

3.5.1.1 It is important that measures to control the introduction or spread of INNS are effective, clear, realistic and easy to communicate to others. These measures also have to take into account how much control is enforceable over the site. A list of example control measures can be found within Cook *et al.* (2015), many of which are included in the INNSMP (see section 4.4). Where possible, biosecurity measures should be included in the in-design stage of a new development and aim to 'design out' any possible significant risk of introducing or spreading INNS.

3.6 Step 5: Biosecurity surveillance, monitoring and reporting procedures

3.6.1.1 This section should outline what procedures should be followed in the event of discovering and positively identifying an INNS on site. All staff and other site users should be encouraged to report any unusual sighting to the biosecurity officer.

3.7 Step 6: Contingency Plan

3.7.1.1 In the event of the 'prevention' and 'rapid response' method fail (section 1.2.1.2) a contingency plan should be created. This document should be short, provide a step-by-step approach of action and be accessible to all staff. This plan should review the identified activities listed and derive actions based on the failure of the biosecurity control measures attributed to the listed activities e.g. a vessel has been wrongly assessed as low risk and has introduced an INNS to site, here the species would be identified, sampled, relevant authorities notified, and further containment measures sought.

3.8 Evaluation and Review

3.8.1.1 Following completion of the INNSMP, a clear recording system and review date should be in place to refine and update the INNSMP as required.

4 META INVASIVE NON-NATIVE SPECIES MANAGEMENT PLAN

4.1 Step 1: Understanding your site

4.1.1 Environmental Conditions Affecting Biosecurity

4.1.1.1 The META project Phase 1 sites (site 1 – 5) are located outside of any environmental designated areas.

4.1.1.2 The META project Phase 2 sites (sites 6 – 8) sit within the Pembroke Marine/Sir Benfro Forol SAC, which is designated for Annex I habitats including estuaries, large shallow inlet and bays, and reefs. Currently the SAC management plan states that there are concerns about the introduction and spread of INNS and as such 'watching briefs' are employed (Pembrokeshire Marine Reg 33 Advice, 2009).

4.1.1.3 Dale Roads (site 7) and East Pickard Bay (site 8) also sit within the West Wales Marine/Gorllewin Cymru Forol SAC which is designated for Harbour Porpoise (*Phocoena phocoena*). The Conservation Objectives and Advice on Operations report (JNCC, 2019) does not list INNS as a concern for this site.

4.1.1.4 The Waterway is a macro-tidal submerged ria with a tidal range of circa 5.5 m and strong tidal flows (≤ 1.2 m/s) near the Cleddau Bridge where the Waterway narrows. However, near Pembroke Dock hydrodynamic regimes are relatively benign due to the presence of geological and manmade features. The water depth ranges from 0 – 30 m throughout the Waterway.

4.1.1.5 The salinity is fully marine from the mouth of the Waterway up to the Daugleddau estuary (beyond Warrior Way (site 6)) and as such all sites can be expected to be fully marine (i.e. around 35 ppt average seawater salinity).

4.1.2 Information related to any slow or stationary periods or climatic conditions that may increase biosecurity risk?

4.1.2.1 Information relating to the environmental conditions of each of the META sites can be found in section 2.2. Due to the location of sites 1 – 5 within Pembroke Dock, tidal flows can be expected to be slow when compared to the rest of the waterway, potentially allowing for INNS to settle within the area and increasing biosecurity risk. The type of testing activities at sites 6 – 8 requires that the marine renewable devices are located within an area of high energy output and as such none of these sites are located within an area of still or slow water flow.

4.1.2.2 Further information for sites 1 – 5 can be found within the META 'Environmental Appraisal Phase 1 sites' document and for sites 6 – 8, further information can be found in the META Environmental Statement 'Chapter 5: Coastal Processes'. Additionally, no climatic conditions have been identified that may increase the biosecurity risk.

4.1.3 INNS in the Waterway

4.1.3.1 Table 4.1 identifies INNS known to occur throughout the Waterway well as identifying the risk of each species represents to Great Britain's native species. Data on the presence of INNS within the Waterway was sought from the NBN Gateway[5] and via personal communications with the environmental manager for the Port of Milford Haven (PoMH). The risk of INNS to native Great Britain species is derived from the non-native species risk analysis process[6].

[5] https://wales-records.nbnatlas.org/search#tab_spatialSearch

[6] Further information on this process can be found at http://www.nonnativespecies.org/index.cfm?sectionid=51

Table 4.1: Non-native species known to be present throughout the Milford Haven area.

	Non-native Species[7]	Risk to native Great Britain species[8]
Present throughout the Waterway and at East Pickard Bay:	• Common slipper limpet *Crepidula fornicata*	High Risk
	• Japanese skeleton shrimp *Caprella mutica* • Japweed *Sargassum muticum* • Jenkins' Spire Snail *Potamopyrgus antipodarum* • Pacific oyster *Crassostrea gigas*	Medium Risk
	• Australian tubeworm *Ficopomatus enigmaticus* • Bay barnacle *Amphibalanus improvisus* • Bryozoan *Bugula neritina* • Bryozoan *Bugula simplex* • Bryozoan *Bugula stolonifera* • Bryozoan Tricellaria inoptiata • Bryozoan *Watersipora subatra* • Colonial sea squirt *Aplidium cf. glabrum* • Colonial sea squirt *Botrylloides c.f. diegensis* • Colonial sea squirt *Botrylloides violaceus* • Colonial sea squirt *Perophora japonica* • Compass sea squirt *Asterocarpa humilis* • Crustacean *Eusarsiella zostericola* • Crustacean *Mytilicola intestinalis* • Darwin's barnacle *Austrominius modestus* • Filamentous red alga *Solieria chordalis* • Green sea fingers *Codium fragile fragile* • Japanese algae *Caulacanthus okamurae* • Leathery Sea Squirt *Styela clava* • Mediterranean mussel *Mytilus galloprovincialis* • Mudshrimp *Monocorophium sextonae* • Orange-striped anemone *Diadumene lineata* • Orange-tipped sea squirt *Corella eumyota* • Oyster Thief *Colpomenia peregrina* • Red seaweed *Anotrichium furcellatum* • Red seaweed *Antithamnionella spirographidis* • Red seaweed *Antithamnionella ternifolia* • Red seaweed *Grateloupia turuturu* • Red seaweed *Polysiphonia harveyi* • Soft-shelled clam *Mya arenaria* • Stalked sea squirt *Styela clava* • Wakame *Undaria pinnatifida*	Risk not assessed / available

4.2 Step 2: Understand how INNS may be introduced or spread to your site

Vessels/equipment to be used in the META project

4.2.1.1 Table 4.2 details the vessels and equipment to be used at each site during the META project and provides a 'risk' indicator for the potential to introduce or spread INNS to the Milford Haven area. This risk assessment has been based on professional judgement, the project description (section 2 *et seq.*), INNS present within the area (Table 4.1) and available guidance (section 3.3; Cook *et al.* 2014).

4.2.1.2 Currently, due to the nature of the project, specific details around the vessels, marine energy devices and ancillary equipment to be used are not yet fully defined and as such, the risk assessment has been undertaken based on maximum scenario assumptions. As stated in paragraph 1.2.1.3, this is a 'live' document and as such, once specific details of the marine energy devices, vessels and ancillary equipment are known, relative to each test deployment, this document will be updated accordingly. For the type of marine renewable devices to be tested throughout the META project, see the META Environmental Statement 'Appendix 2.1: Summary of Device Types'.

[7] Sources: GB NNSS (undated): NBN gateway (Undated); PNP (2017); PoMH (pers. comms.).

[8] According to assessment by NNSS (www.nonnativespecies.org/index.cfm?sectionid=51).

Table 4.2: Vessel/equipment types using the site and/or involved in the operation

Name	Type	Details & Risk factors assumptions	Risk: Low/Significant
Phase 1 sites			
Vessels	Various	• Vessel size for installation, operation and maintenance, and removal of marine energy devices is maximum length of 35 m, and a maximum draught of 6.8 m; • Vessels supporting deployment and retrieval will be sourced from Pembroke Port; • Frequency of operation and maintenance: twice weekly; • Vessels are expected to have an anti-fouling coating and inspection history; • Vessels are expected to move slowly when installing or removing a marine energy device; and • Up to five vessels may be utilised in deployment and retrieval operations at any one time.	Low
Marine Energy Devices	Various	• One device (Carr Jetty and Criterion Jetty) and two devices (Ferryside, Mainstay Quay and Quay 1) deployment occurring at any one time within the test area; • Device will be either towed to site or deployed from land; • Device will occupy all or part of the water column; • Device area: up to 100 m^2 (1360 m^2 for Quay 1); • Wave component: Components or subassemblies may be up to 80 m length 17 m width and 5.5 m draught; • Tidal component: 5 m x 5 m, rotor diameter up to 5 m with speed of moving part up to 2 m/s; • Any antifoulants or lubricants used will be EU/Internationally approved for use in marine environments; and • Maximum duration 6 months (75% of time in water).	Low
Ancillary equipment	Gravity Base	• Restricted area gravity bases may be required; and • Maximum area 25 m^2 in contact with the sea bed.	Low
	Moorings system	• Four-point anchoring system (modular) within maximum seabed footprint per component or subassembly. • Maximum mooring spread of up to 100-144 m^2 per component/subassembly	Low
	Pontoon (Ferryside (site 3) only)	• Four pontoons (pontoon) will be tethered to existing dolphins; • Access brow for Pontoon (2 m x 15 m); and • Pontoon (248 m^2) to be in-situ all year round with removals for maintenance every five years.	Significant
Warrior Way (site 6)			
Vessels	Various	• Vessel size for installation, operation and maintenance, and removal of marine energy devices is maximum length of 35 m, and a maximum draught of 6.8 m; • Vessels supporting deployment, operation and retrieval will be sourced from Pembroke Port; • Vessels are expected to have an anti-fouling coating and inspection history; • Vessels are expected to move slowly when installing or removing a marine energy device; and • Up to five vessels may be utilised in deployment and retrieval operations at any one time.	Low
Marine Energy Devices	Various	• One device deployment occurring at any one time within the test area; • Device will be towed to site; • Device will occupy all or part of the water column; • Device area: up to 200 m^2; • Dimensions of tidal component: 20 m x 10 m; • Rotor diameter up to 5m with swept area of up to 19.63 m^2 • Any antifoulants or lubricants used will be EU/Internationally approved for use in marine environments; and • Maximum duration 6 months (100% of time in water).	Low
Ancillary equipment	Gravity Base	• Maximum area 25 m^2 in contact with the sea bed; and • Only deployed for the duration of the testing activity.	Low

Name	Type	Details & Risk factors assumptions	Risk: Low/Significant
	Buoys	• Up to four navigational marker buoys; and • Only deployed for the duration of the testing activity.	Low
	Moorings system	• Mooring spread: 150 m^2; and • Up to four drag anchors with associated slack lines, catenary mooring system.	Low
Dale Roads (site 7)			
Vessels	Various	• Vessel size for installation, operation and maintenance, and removal of marine energy devices is maximum length of 164 m, and a maximum draught of 6.8 m; • Vessels supporting deployment, operation and retrieval will be sourced from Pembroke Port; • Vessels are expected to have an anti-fouling coating and inspection history; • Vessels are expected to move slowly when installing or removing a marine energy device; and • Up to five vessels may be utilised in deployment and retrieval operations at any one time.	Low
Marine Energy Devices	Various	• One device deployment occurring at any one time within the test area; • Device will be towed to site; • Wave component testing may occupy a significant proportion of the water column and may include surface-piercing; • Device footprint: up to 600 m^2 on seabed; • Dimensions of component: 30 m x 20 m; • Any antifoulants or lubricants used will be EU/Internationally approved for use in marine environments; and • Maximum duration 12 months (100% of time in water).	Low
Ancillary equipment	Gravity Base	• Maximum area 500 m^2 in contact with the sea bed; and • Only deployed for the duration of the testing activity	Significant
	Buoys	• Up to four navigational marker buoys; • Only deployed for the duration of the testing activity; and • A test-support buoy capable of dissipating energy at site may also be provided.	Low
	Moorings system	• Mooring spread: 200 m^2; and • Up to 10 drag anchors with associated slack lines, catenary mooring system.	Low
	Pin pilling	• Maximum diameter of the pin piles: 100mm; and • Drilled to a depth of 10 m and 20 m below sea bed.	Low
East Pickard Bay (site 8)			
Vessels	Various	• Vessel size for installation, operation and maintenance, and removal of marine energy devices is maximum length of 200 m, and a maximum draught of 8 m; • Vessels supporting deployment, operation and retrieval will be sourced from local ports (Wales); • Vessels are expected to have an anti-fouling coating and inspection history; • Vessels are expected to move slowly when installing or removing a marine energy device; and • Up to five vessels may be utilised in deployment and retrieval operations at any one time.	Low
Marine Energy Devices	Various	• Up to two marine energy devices may be deployed at any one time (a single device at each of two test berth). • Minimum duration of deployment is up to 6 months therefore up to four test deployment in any 12-month period; • Devices may be towed to site or towed on a barge; • Wave component testing may occupy a significant proportion of the water column and may include surface-piercing.; • Device footprint: 33,810 m^2 (sea surface); 8,000 m^2 (seabed)	Significant

Name	Type	Details & Risk factors assumptions	Risk: Low/Significant
		• Dimensions of component: 147 m x 230 m; • Any antifoulants or lubricants used will be EU/Internationally approved for use in marine environments; and • Duration of tow testing activity up to three months (50% of time in water); and • Maximum duration 18 months (100% of time in water).	
Ancillary equipment	Gravity Base	• Maximum area 1,125 m^2 in contact with the sea bed; and • Only deployed for the duration of the testing activity.	Significant
	Buoys	• Up to four navigational marker buoys; • Only deployed for the duration of the testing activity; and • A test-support buoy capable of dissipating energy at site may also be provided.	Low
	Moorings system	• Mooring spread: 250,000 m^2 per test activity; and • Up to 3-point catenary mooring system or up to 10 standard drag embedment anchors.	Low
	Pin pilling	• Maximum diameter of the pin piles: 100mm; and • Drilled to a depth of 10 m and 20 m below sea bed.	Low

4.3 Step 3: Understand the site activities

A list of META project activities that may have a significant risk of introducing or spreading INNS has been provided in Table 4.3. These have been derived from information in the project description and from step 1 (section 4.1) and step 2 (section 4.2). Whilst step 2 found that Ferryside (site 3), Dale Roads (site 7) and East Pickard Bay (site 8) represented a potentially significant risk of INNS introduction and spread from marine energy devices, gravity bases and the presence of the pontoon (Table 4.2), step 1 has identified all sites as having a **significant risk** of introduction or spread of INNS due to the presence of INNS throughout the Waterway and therefore using the precautionary principle, the biosecurity control measures outlined below (section 4.4) should be applied to all META test sites.

Table 4.3: Site activities which have a significant risk of introducing or spreading INNS.

Phase	Activity Description
Installation	• Provision of temporary moorings. • Installation of man-made structures (i.e. marine energy devices and ancillary equipment). • Using vessels from outside of the Milford Haven area.
Operation and Maintenance	• Presence of man-made structures (i.e. marine energy devices and ancillary equipment). • Maintaining marine energy devices and ancillary equipment.
Decommissioning	• Removal of marine energy devices and ancillary equipment. • Cleaning and disposal of biofouling from marine energy devices and ancillary equipment.

4.4 Step 4: Biosecurity control measures

4.4.1 Provision of temporary moorings

Risk

4.4.1.1 Moorings are expected to remain in-situ for up to 18 months. The introduction of a novel surface and the duration which it is present may result in INNS colonising mooring structures put in place to support marine energy devices. Any structure that has been in the water for just a few weeks, particularly in the summer months when high risk INNS typically reproduce (Sewell and sweet, 2011; Coutts, 2002; Ram *et al.*, 1992), without an anti-fouling coating, will be at risk from INNS settlement.

Control Measure

4.4.1.2 Any moorings to be used for the META project should be of terrestrial origin (i.e. not coming from another marine environment) or if being re-used for another marine energy device, following removal, should be allowed to fully dry to kill off any organisms that have attached. If possible a surplus of mooring equipment should be available to allow for a 'rotation' of equipment and to allow sufficient drying time, using the Check, Clean and Dry method[9].

4.4.2 Installation/presence of man-made structures

Risk

4.4.2.1 This may pose one of the greatest risks of INNS introduction or spreading associated with the META project. New or clean surfaces in ports, marinas and waterways are typically the first colonisation sites for INNS due to their ability to settle and rapidly proliferate. Newly available hard surfaces (marine energy devices, ancillary equipment or the presence of a pontoon) associated with the META project may be susceptible to colonisation by INNS in the first few weeks/months after installation. Several INNS are already known to exist in the Waterway and are of high and medium risk to native Great Britain fauna, these include the Common slipper limpet *Crepidula fornicate*, Japanese skeleton shrimp *Caprella mutica,* Japweed *Sargassum muticum*, Jenkins' Spire Snail *Potamopyrgus antipodarum* and Pacific oyster *Crassostrea gigas* (Table 4.1). A risk assessment (NNSS, 2011; Sewel and Sweet, 2011: NNSS, 2005) on the threat that these particular organism poses to Great Britain concluded that entry and introduction were very likely, spread would be rapid and the impact would be massive.

Control Measure

4.4.2.2 The control measures for this activity can be expected to be similar to those presented in paragraph 4.4.1.2, to prevent the introduction or spread of INNS to the area.

4.4.3 Using vessels from outside of the Waterway

Risk

4.4.3.1 Using vessels from outside the Waterway poses a significant risk of introducing INNS to the area, especially vessels coming from areas of similar marine environment (other marine estuaries). It is understood that for the META project, sites 1 - 7 will only use vessels based at Pembroke Port and will not pose a significantly increased risk. Vessels to be used at East Pickard Bay (site 8) may originate from other Welsh ports, however, these ports have not been specified yet but will be updated once further details are known, in association with each test deployment in META.

Control Measure

4.4.3.2 All vessels to be used to transit marine energy devices and ancillary equipment must follow guidance as directed by the 'Guidelines for the control and management of ships' biofouling to minimize the transfer of

[9] See: http://www.nonnativespecies.org/checkcleandry/ for the Check, Clean and Dry Method.

invasive aquatic species'[10], and where applicable, to comply with the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments'[11].

4.4.4 Maintaining/presence marine energy devices, ancillary equipment and pontoon

Risk

4.4.4.1 With operation and maintenance checks occurring intermittently during device testing, there is a possibility to transport INNS from one location to another. INNS during the summer months will reproduce and release eggs and larvae into the water column as plankton. Vessels carrying out operations and maintenance on marine energy devices and ancillary equipment without an anti-fouling coating will be susceptible to INNS attachment.

Control Measure

4.4.4.2 Regular checks of vessel hulls and ensuring an anti-fouling coating has been applied should prevent spread of INNS. Where the pontoon is concerned, checks will made in line with Milford Haven Port Authority's standard protocols, which currently follows the Check, Clean and Dry method. .

4.4.5 Removal of marine energy devices and ancillary equipment

Risk

4.4.5.1 Over the course of the operational phase, INNS may colonise marine energy devices, ancillary equipment and pontoon.

Control Measure

4.4.5.2 Checks should be in place for INNS prior to removal and reuse, to avoid the spread of INNS. Should these structures have INNS and still require reuse (such as the pontoon), then a clearing and recheck procedure should be agreed with the statutory authorities before implementation.

4.4.6 Cleaning and disposal of biofouling from marine energy devices and ancillary equipment.

Risk

4.4.6.1 Following removal of marine energy devices and ancillary equipment, INNS may still be attached to the surface. Should the INNS be removed without due care and washed back into the Waterway, INNS may represent a risk of spreading to areas where INNS were not previously present.

Control Measure

4.4.6.2 Any material detached or removed from marine energy devices, ancillary equipment and pontoon should be prevented from re-entering the marine environment, taken away and properly disposed of onshore. Control measures taken in relation to disposal of biofouling will be aligned with the Milford Haven Port Authority Management Procedure MP 020 Rev D 'Waste Management Plan'.

4.4.7 Biosecurity Action

4.4.7.1 Prior to any installation/operation of new vessels, marine energy devices and ancillary equipment to site, device developers and their contractors must include the following biosecurity clauses:

- The contractor must submit a Biosecurity Risk Assessment to META Operations and Environment Manager for approval;
- The contractor must ensure that all equipment, materials, machinery, PPE and vessels used are in a clean condition prior to their arrival on site to minimise the risk of INNS introduction into the marine environment.

[10] For more information, see: http://www.imo.org/en/OurWork/Environment/Biofouling/Pages/default.aspx

[11] For more information, see: http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx

4.5 Step 5: Biosecurity surveillance, monitoring and reporting procedures

4.5.1.1 Instructions for checks of INNS are described in Table 4.4.

Table 4.4: Instructions for Staff/ Contractors/ Site Users.

Who	What	Where	When
META Operations Manager, developers and contractors	• Oversee removal of flora and fauna from marine energy devices and ancillary equipment, ensure material is properly disposed of and that no material is released into the water as per the Milford Haven Port Management Procedure MP 020 'Waste Management Plan'. • Awareness of INNS, including identification guidance on the key risk species. If not sure follow the contingency plan.	At Port	Beginning of works
META Operations Manager or appropriate contractor	• Oversee installation and removal of marine energy devices and ancillary equipment, check for INNS or unknown organisms. • For operation and maintenance, periodic checks should be carried out after 2 months to ensure no growth/settlement of INNS. • Be aware of any slow moving or inactive craft and take steps to assess risk. • Ensure a Check, Clean and Dry message is sent to any new developers or contractors. • Where possible the META Operation Manager will collaborate with the Milford Haven Port Authority and other users of the Waterway to raise INNS awareness.	At Port	Throughout works
Developers and contractors	• Confirm origin of material used in constructing of marine energy devices and ancillary equipment (i.e. terrestrial origin, not previously submerged in marine water). • Encourage 'tool box' talks on INNS prevention and monitoring.	n/a	Beginning of works
META Operations Manager, developers and contractors	• Through collaboration with the Regulators including NRW and Port of Milford Haven META will develop measures appropriate to the individual test deployments specific to the deployment site and nature and duration of testing on a case by case basis	n/a	Prior to works commencing
META team as a member of the Milford Haven Waterway Environmental Surveillance Group (MHWESG)	• Through membership of MHWESG, the META team will contribute to and facilitate ongoing surveillance, monitoring and reporting of INNS within the wider waterway. This will also ensure that any new risks (arising from our location in a busy industrial waterway) and thus potential mitigation requirements are well understood and enacted as soon as possible	n/a	As required

[Live Document: Additional information to be provided by META Operations Manager as and when required]

4.6 Step 6: Contingency Plan

Action	Responsibility
Stage One – Suspected arrival of high alert species	
Take photographs of sample and collect sample in a plastic bag.	Designated biosecurity officer, site manager, Ecological Clerk of Works (ECOW), or any member of staff.
Check organism against identification sheet (available at http://www.nonnativespecies.org/index.cfm?sectionid=47) Phone the GB Non-Native Species Secretariat (NNSS) Hotline: 0845 1306 229, Email alertnonnative@ceh.ac.uk for further information on sending sample and photographs.	Designated biosecurity officer, site manager, Ecological Clerk of Works (ECOW), or any member of staff.
Inform site users and mark the area (e.g. buoys or marker tape).	Designated biosecurity officer, site manager, Ecological Clerk of Works (ECOW).
Stage Two – Presence of high alert species confirmed	
Initiate immediate containment measures, including restricted vessel movements.	Designated biosecurity officer, site manager, Ecological Clerk of Works (ECOW).
Carry out wider survey of vessels and structures.	Designated biosecurity officer, qualified ecologist.
Stage Three – Eradication/employ long-term control measures	
Seek advice from NNSS on appropriate eradication and long-term control measures.	Designated biosecurity officer, site manager.

4.7 Evaluation and Review

4.7.1 Location of Biosecurity Logbook

4.7.1.1 A biosecurity logbook will be kept in electronic form for each META test area at the Pembrokeshire Coastal Forum offices and will be made available for inspection and review as and when required.

4.7.2 Plan Review Date

4.7.2.1 This Plan will be reviewed annually. However, updates are expected to be carried out in response to each individual test deployment to ensure that it is appropriate to the nature, timing, duration and location of the deployment. These updates will be made available to the relevant regulatory authorities within the time frames established as part of the consenting process.

5 USEFUL SOURCES OF INFORMATION

- IMO Guidelines for the control and management of ships biofouling to minimize the transfer of invasive aquatic species: http://www.imo.org/blast/blastDataHelper.asp?data_id=30766
- Marine Biosecurity Planning Guidance (Cook *et al.*, 2014): http://www.snh.gov.uk/docs/A1294630.pdf
- GB non-natives species secretariat: www.nonnativespecies.org/
- Non - native species records can be accessed via the local record centres http://www.lrcwales.org.uk/?AspxAutoDetectCookieSupport=1
  - or the National Biodiversity Network http://www.nbn.org.uk/
  - or the marine biological Association http://www.mba.ac.uk/
- For Risk Assessments of High and Medium species present in the Waterway. See: http://www.nonnativespecies.org/index.cfm?pageid=143

6 REFERENCES

Cook, E.J., Macleod, A. Payne, R.D., and Brown, S. (2014). edited by Natural England and Natural Resources Wales (2015). Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction and spread of non-native species in England and Wales.

Coutts A.D.M., (2002). A biosecurity investigation of a barge in the Marlborough Sounds. Cawthron Report, vol. 744. Cawthron Institute, Nelson, New Zealand. July 2002. 59 pp.

Evans, D. H. (1980). Osmotic and ionic regulation by freshwater and marine fishes. In Environmental physiology of fishes (pp. 93-122). Springer, Boston, MA.

GB NNSS (undated). Great Britain Non-native Species Secretariat. Available online: www.nonnativespecies.org.

JNCC (2019). Harbour Porpoise (*Phocoena phocoena*) Special Area of Conservation: West Wales Marine/Gorllewin Cymru Forol. Conservation Objectives and Advice on Operations.

MarLIN (undated). Marine Life Information Network. Available online: www.marlin.ac.uk

META EIA Scoping Report (2018).

NBN Gateway (undated). National Biodiversity Network. Available online: https://data.nbn.org.uk.

Pembrokeshire Marine Reg 33 Advice (2009). Advice provided by the countryside council for wales in fulfilment of regulation 33 of the conservation (natural habitats, &c.) Regulations 1994: Management Plan. Available online: https://naturalresources.wales/media/673806/Pembrokeshire%20Marine%20Reg%2033%20Advice%20Feb%202009.doc.pdf

PNP (2017). Species Action Plan: Invasive Non-Native Species (INNS). Pembrokeshire Nature Partnership.

NNSS (2011) UK non-native organism risk assessment scheme: capet sea squirt - Didemnum sp. Risk assessment available via http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=1209

NNSS (2005) UK non-native organism risk assessment scheme: Zebra Mussel - Dreissena polymorpha. Risk assessment available via http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=1250

Ram, J. L., Fong, P.P., Croll, R.P., Nichols, J.S. & Wall, D.M. (1992). The Zebra Mussel (Dreissena polymorpha), a new pest in North America: reproductive mechanisms as possible targets of control strategies. Invert. Rep. Dev. 22, 77-86.

GB NNSS (2008). The invasive non-native species framework strategy for Great Britain. Defra, London.

Sewell, J. and Sweet, N. (2011). GB Non-native Organism Risk Assessment for Crepidula fornicata.www.nonnativespecies.org

Wood, C., Bishop, J., and Yunnie, A. (2015). Comprehensive Reassessment of NNS.