MARICO MARINE

RPS ENERGY CONSULTANTS LIMITED

PEMBROKE DOCK DEVELOPMENT NAVIGATION RISK ASSESSMENT

Report Number: 18UK1496 - PD
Issue: 03
Date: 30 September 2019

UK HMA | British Ports Association | IHMA

MARINE AND RISK CONSULTANTS LTD

RPS ENERGY CONSULTANTS LIMITED

PEMBROKE DOCK DEVELOPMENT NAVIGATION RISK ASSESSMENT

Prepared for: RPS Energy Consultants Limited
20 Western Avenue
Milton Park
Abingdon
Oxfordshire
OX14 4SH

Author(s): William Heaps

Checked By: Rebecca Worbey

Date	Release	Prepared	Authorised	Notes
23 April 2019	Draft A	WH	RW	For Client Comment
5 June 2019	Issue 01	WH	RW	For Client Issue
11 June 2019	Issue 02	WH	RW	For Client Issue
30 Sept 2019	Issue 03	WH	RW	Updated figures, addressed client comments.
06 Dec 2019	Issue 04			Document Finalised

Marine and Risk Consultants Ltd
Marico Marine
Bramshaw
Lyndhurst
Hampshire
SO43 7JB
United Kingdom

Tel. + 44 (0) 2380 811133

30 September 2019

EXECUTIVE SUMMARY

RPS Energy Consultants Limited (RPS) commissioned Marine and Risk Consultants Ltd (Marico Marine) to undertake a Navigation Risk Assessment (NRA) for the proposed redevelopment of part of Pembroke Dock within the Milford Haven Waterway (the Waterway) in South West Wales. The intention of the proposed development is to create a flexible and efficient port-related office, industrial, warehousing and distribution and ancillary area capable of meeting the needs of the modern blue economy (meaning the sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health) that will provide a significant contribution to the £1.3 Bn Swansea Bay City Deal. This will involve the intensive use of land side areas for fabrication, repair and servicing of boats, renewable energy devices, transporting cargo and other works requiring marine access, served by an appropriately structured highly flexible enlarged slipway.

The Pembroke Dock redevelopment, known as Pembroke Dock Infrastructure (PDI), is closely linked to a separate project (the Marine Energy Test Area (META) Project) for the testing of wave and tidal energy devices within and close to the Waterway, and therefore a joint NRA process has been undertaken for both projects. The Pembroke Dock and META projects are reported separately but based on the common NRA process.

The joint assessment was guided by the Maritime and Coastguard Agency's (MCA's) Marine Guidance Note (MGN) 543 standard for assessing Offshore Renewable Energy Installations (OREIs) as this provides best practice advice. In addition, advice given within "A Guide to Good Practice on Port Marine Operations (Prepared in conjunction with the Port Marine Safety Code)" (DfT, February 2018) has been followed as appropriate.

The NRA has comprehensively reviewed existing traffic densities within the proposed project area and considered how navigation will be affected by the construction and operation of the redeveloped port infrastructure. A quantitative assessment has been undertaken.

Existing conditions were assessed by means of assessing data including:

- AIS Traffic records for both winter and summer periods;
- Port Authority traffic data;
- Incident data (MAIB and Port Authority);
- Additional traffic data (RYA, ferry schedules); and
- Extensive stakeholder consultation (local groups and individuals, MHPA, MCA, Trinity House).

Current and potential future hazards were identified, as well as existing and possible future control measures. All hazards assessed were scored within the ALARP region. The construction and operation of

the proposed development either in isolation or in combination with the proposed META project is not expected to increase the risk associated with any of the identified navigation hazards to an unacceptable level, assuming all existing risk controls are maintained.

There is an opportunity to reduce risk still further, and additional risk controls have been proposed.

CONTENTS

FIGURES

TABLES

ANNEXES

ABBREVIATIONS

Abbreviation	Detail
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ATBA	Area to be Avoided
AtoN	Aid to Navigation
CGOC	Coastguard Operations Centre
DECC	(Former) Department of Energy and Climate Change
ERCoP	Emergency Response and Cooperation Plan
FSA	Formal Safety Assessment
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HMCG	Her Majesty's Coast Guard
HSE	Health and Safety Executive
HW	High Water
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organisation
km	Kilometre
kt	Knot (unit of speed equal to nautical mile per hour, approximately 1.15 mph)
LAT	Lowest Astronomical Tide
LOA	Length Over-All
LW	Low Water
m	Metre
MAIB	Marine Accident Investigation Branch
Marico Marine	Marine and Risk Consultants Ltd
MCA	Maritime and Coastguard Agency
META	Marine Energy Test Area Project
MGN	Marine Guidance Note
MHPA	Milford Haven Port Authority
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
ML	Most Likely
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs

Abbreviation	Detail
MSL	Mean Sea Level
MW	Megawatt
nm	Nautical Mile
NRA	Navigation Risk Assessment
NTM	Notice To Mariners
O&M	Operations and Maintenance
OREI	Offshore Renewable Energy Installation
PDI	Pembroke Dock Infrastructure
PIANC	Permanent International Association of Navigation Congresses
PMSC	Port Marine Safety Code
RHIB	Rigid Hulled Inflatable Boats
RNLI	Royal National Lifeboat Institution
RORO	Roll-On Roll-Off (Vehicle Carriers)
RPS	RPS Energy Consultants Limited
RYA	Royal Yachting Association
SAR	Search and Rescue
SHA	Statutory Harbour Authority
SMS	Safety Management System
STCW	Standards of Training Certification and Watchkeeping
TEC	Tidal Energy Converter
THLS	Trinity House Lighthouse Service
UKC	Under Keel Clearance
UKHO	UK Hydrographic Office
VHF	Very High Frequency (radio communication)
VLCC	Very Large Crude Carrier
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WC	Worst Credible
WEC	Wave Energy Converters
WGS	World Geodetic System

1 INTRODUCTION

RPS Energy Consultants Limited (RPS) commissioned Marine and Risk Consultants Ltd (Marico Marine) to undertake a Navigation Risk Assessment (NRA) for the proposed redevelopment of part of Pembroke Dock in the Milford Haven Waterway (the Waterway), South West Wales. The intention of the proposed development is to create a flexible and efficient port-related office, industrial, warehousing and distribution and ancillary area capable of meeting the needs of the modern blue economy (meaning the sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health) that will provide a significant contribution to the £1.3 Bn Swansea Bay City Deal. This will involve the intensive use of land side areas for fabrication, repair and servicing of boats, renewable energy devices, transporting cargo and other works requiring marine access, served by an appropriately structured highly flexible enlarged slipway.

The Pembroke Dock redevelopment, known as Pembroke Dock Infrastructure (PDI), is closely linked to a separate project (the Marine Energy Test Area (META) Project) for the testing of wave and tidal energy devices within and close to the Waterway and, therefore a joint NRA process has been undertaken for both projects. The Pembroke Dock and META projects are reported separately but based on the common NRA process.

The joint assessment was guided by the Maritime and Coastguard Agency's (MCA's) Marine Guidance Note (MGN) 543 standard for assessing Offshore Renewable Energy Installations (OREIs) as this provides best practice advice. In addition, advice given within "A Guide to Good Practice on Port Marine Operations (Prepared in conjunction with the Port Marine Safety Code)" (DfT, February 2018) has been followed as appropriate.

This report describes the development at Pembroke Dock and includes the formal NRA applicable to that project.

2 STUDY AREA

Figure 1 shows the Study Area under assessment. The Study Area encompasses the Pembroke Dock redevelopment area (see **Figure 2**) and extends to include the context of the immediate approaches to Pembroke Dock including "Dockyard Bank" and the two approach channels.

The marine components assessed for navigational safety impacts are the Carr Jetty area, and general approaches to the port.

It is noted that most commercial traffic approaches from the west, and passes to the north of Dockyard Bank, before turning south at the eastern end of the bank. However, some shallow draft vessels do use the channel to the west of Dockyard Bank.

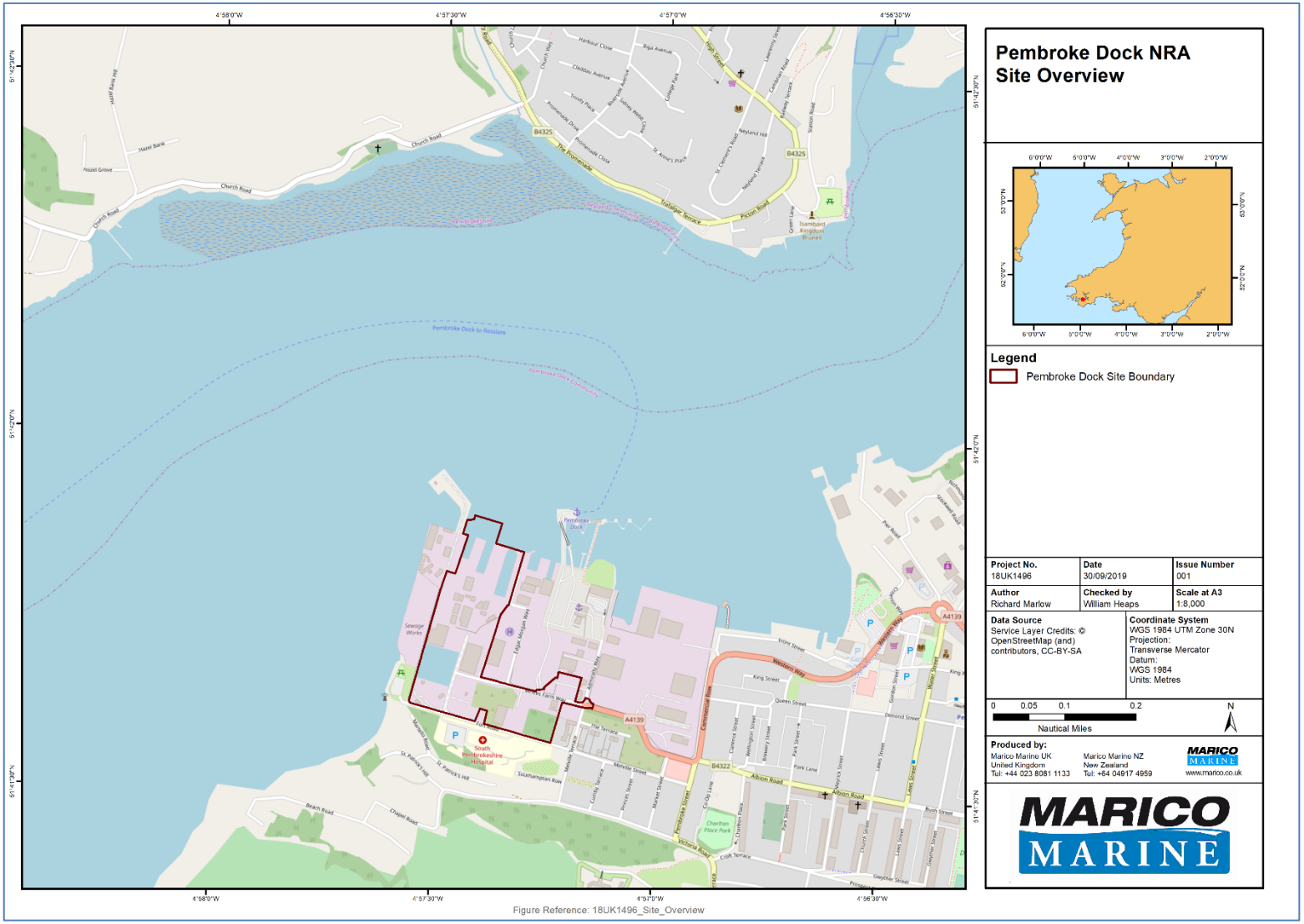


Figure 1: Pembroke Dock Study Area including Application Boundary.

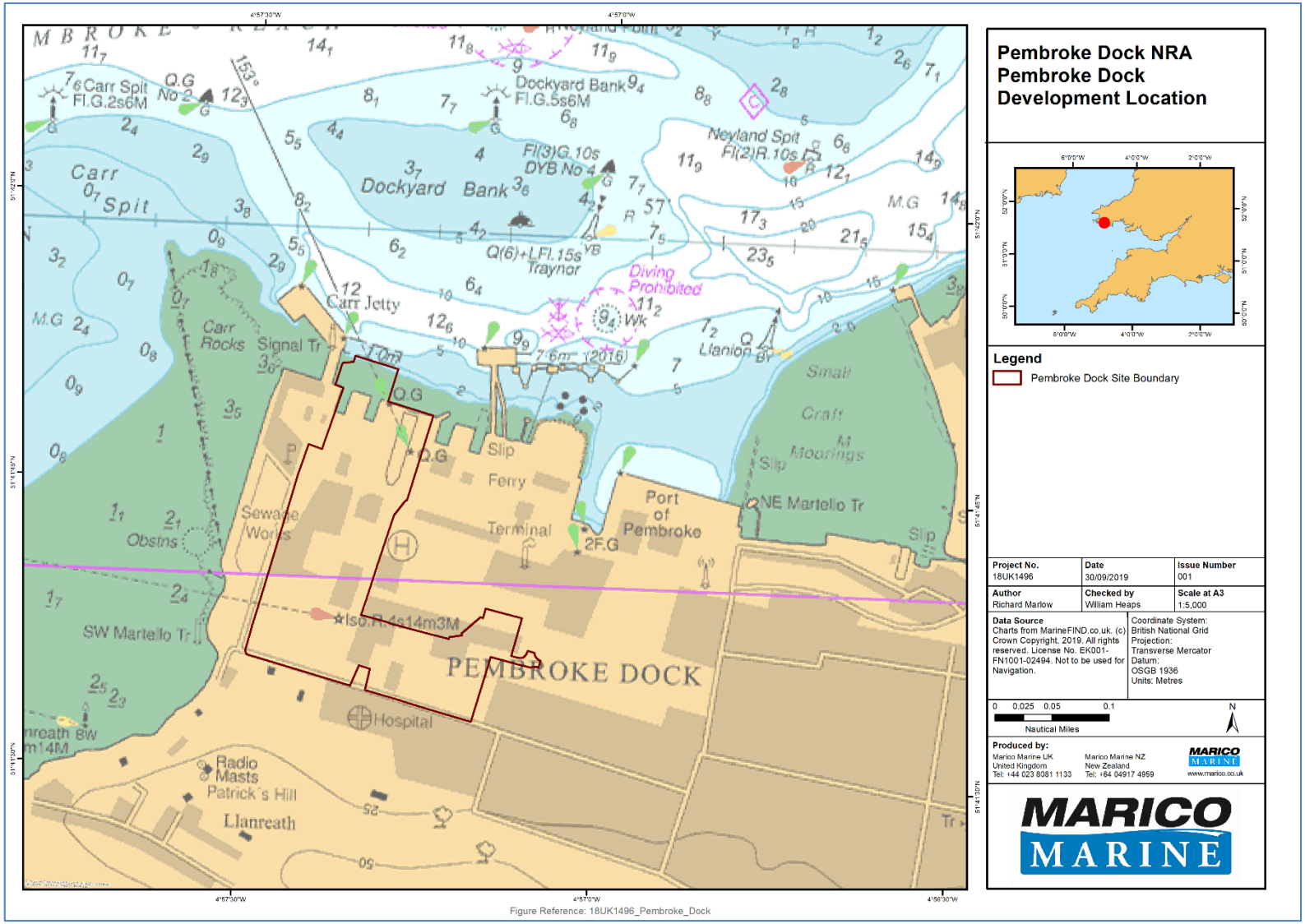


Figure 2: Location of Pembroke Dock Development including Application Boundary.

2.1 SCOPE AND METHODOLOGY

The scope of this assessment is to:

1) Describe the project site;
2) Provide a description of the existing environment and activities in the study area, including:
    a. Local ports and harbours;
    b. Met-Ocean conditions;
    c. Existing vessel management plans;
    d. Other uses of the area such as aquaculture, anchorages, military and renewable energy installations;
    e. Existing vessel traffic patterns, including frequency and types; and
    f. Existing risk profile for navigational incidents.
3) Determine likely future traffic profile;
4) Identify and assess impacts associated with the development to shipping and navigation, including:
    a. Traffic routeing;
    b. Collision risk;
    c. Contact risk;
    d. Communications, radar and positioning systems;
    e. Search and rescue; and
    f. Cumulative and in-combination effects;
5) Undertake an NRA that identifies navigational hazards during the development and future operation of the Port. These hazards are assessed, and risk controls identified to reduce the risk to As Low as Reasonably Practicable (ALARP); and
6) Make recommendations as to the navigation safety of the project site and identify any additional measures that should be implemented to further improve safety at the site.

2.2 GUIDANCE

As stated in the introduction, this NRA draws on relevant guidance given in the MCA's MGN 543 (M+F) which sets out the methodology for evaluating navigational safety around OREIs through traffic surveys. Reference has also been made to the Port Marine Safety Code, and the supporting "Guide to Good Practice" as the development is entirely within a Statutory Harbour Authority area. Further guidance is given in other publications as described in **Table 2-1**.

The NRA has been undertaken using the IMO approved Formal Safety Assessment (FSA) methodology (Described in **Annex A**).

Table 2-1: Guidance Documents.

Guidance	Key provisions
Port Marine Safety Code	Sets out a national standard for every aspect of port marine safety.
A Guide to Good Practice on Port Marine Operations (Prepared in conjunction with the Port Marine Safety Code)	Supplements the Port Marine Safety Code. Contains useful information and additional guidance relevant to the management of ports and other marine facilities.
MGN 543 Guidance on UK Navigational Practice, Safety and Emergency Response Issues.	This MGN highlights issues to be considered when assessing the impact on navigational safety and emergency response, caused by OREI developments. Including traffic surveys, stakeholder consultation, structure layout, collision avoidance, impacts on communications/ radar/ positioning systems and hydrography.
International Maritime Organisation (IMO) (2018) Formal Safety Assessment.	Process for undertaking marine navigation risk assessments.

Table 2-2 acts as an aid for OREI developers when completing and submitting an NRA to the MCA to ensure all guidance has been considered and addressed. While it is not required that this assessment is undertaken in full compliance with the MGN, the table shows that relevant aspects of the MGN have been addressed within this assessment.

Table 2-2: MGN 543 Compliance Table.

MGN 543 Annex 1		Report Section
1	An up to date traffic survey of the area	**Section 4** – Consultation **Section 6** – Existing Vessel Traffic at Pembroke **Section 9** – Potential Impacts to Navigation
2	OREI structures	**Section 9** – Potential Impacts to Navigation
3	Assessment of access to and navigation within, or close to, an OREI	**Section 9** – Potential Impacts to Navigation **Section 10.3** – Risk Control Options
MGN 543 Annex 2		**Report Section**
1	Effects of tides and tidal streams	**Section 5.1** – MetOcean Conditions **Section 9.3** – The Effects of Tides, Tidal Streams and Weather
2	Weather	**Section 5.1** – MetOcean Conditions **Section 9.3** – The Effects of Tides, Tidal Streams and Weather
3	Visual navigation and collision avoidance	**Section 9** – Potential Impacts to Navigation
4	Communications, radar and positioning systems	**Section 9.9** - Impact on Communications, Radar and Positioning Systems
5	Marine navigational marking	**Section 10.5** - Possible Additional Risk Controls
MGN 543 Annex 3		**Report Section**
1	MCA Shipping Route Template	**Section 9.1** – Impact on Vessel Traffic Routeing
MGN 543 Annex 4		**Report Section**
1	Safety and mitigation measures	**Section 10.3** – Risk Control Options
MGN 543 Annex 5		**Report Section**
1	Emergency response	**Section 9.8** – Impact on Search and Rescue and Emergency Response

3 PEMBROKE DOCK INFRASTRUCTURE

3.1 OVERVIEW

The intention of the proposed redevelopment is to create a flexible and efficient port-related office, industrial, warehousing and distribution and ancillary area capable of meeting the needs of the modern blue economy (meaning the sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health) that will provide a significant contribution

to the £1.3 Billion Swansea Bay City Deal. This will involve the intensive use of landside areas for fabrication, repair and servicing of boats, renewable energy devices, transporting cargo and other works requiring marine access, served by an appropriately structured highly flexible enlarged slipway.

The proposed redevelopment will include an enlarged single slipway at Gate 4 to facilitate the efficient transfer of vessels and marine renewable devices between land and sea, together with the formation of large 'lay down' open areas to facilitate working on boats and devices without occupying slipways. The new single slipway will modify or replace two existing smaller slipways and will be designed such that the historic fabric of the outer walls of these two smaller slipways will be retained.

3.2 MARINE COMPONENTS OF THE PROJECT

Details of the marine activities associated with the PDI project have been provided in the project description of the Environmental statement. The proposed works will include:

- The creation of a single large slipway, with an area 75 m by 85 m, by combining the two existing westernmost slipways and extending the slipway into the Waterway into deeper water;
- Capital dredging around the slipways;
- Removal of accumulated sediments and debris within the Graving Dock;
- The infilling of the Graving Dock; and
- The infilling of the timber/pickling pond.

4 CONSULTATION

4.1 CONSULTEES

Consultation was carried out with key stakeholders to gain local knowledge and insight on navigation. This was predominantly achieved through a half-day stakeholder meeting held at Pembroke Port on Wednesday 30 January 2019.

In addition, telephone consultation was undertaken with the MCA and Trinity House Lighthouse Services (THLS).

Further detailed consultation was undertaken during a visit to the offices of MHPA on the afternoon of 30 January 2019, with the chief aim of obtaining additional data and traffic information.

Table 4-1 and **Table 4-2** set out the list of stakeholders consulted including the list of workshop attendees. Where stakeholders were unable to attend the workshop, telephone and/or email consultation was undertaken where possible, as indicated within **Table 4-2**.

A summary of all consultation is given in **Table 4-1.**

Table 4-1: List of stakeholders consulted (workshop attendees).

Company
Marine Energy Wales
RPS
Marico
Port of Milford Haven
Dale Yacht Club
Valero
Pembroke Yacht Haven
Puma Energy
Milford Harbour Users Association (MHUA)
Warrior Cove Pembrokeshire Activity Centre & Pembrokeshire Performance Sailing Academy

Table 4-2: List of stakeholders consulted (workshop apologies).

Company
MHPA
Pembroke Haven Yacht Club
Irish Ferries (supplied email comment)
MCA (phone consultation)
THLS (phone consultation)
RNLI

The following individuals / organisations did not respond to the consultation invitation:

- Milford Haven Fisheries Group
- South Wales Sea Fisheries Committee
- Welsh Federation of Sea Anglers
- Pembrokeshire Cruiser Racing Club
- Lawrenny Yacht Club
- Neyland Yacht Club
- PYC – Gelliswick
- Williams Shipping
- Svitzer
- SMIT – Range Safety Boat
- South Hook LNG
- Dragon LNG

4.2 CONSULTATION SUMMARY

Table 4-3: Consultation Summary.

Date	Consultee and type of response	Issues raised
4 October 2018	NRW (Scoping Opinion)	The Environmental Statement must include a Navigational Risk Assessment and show how the works – both during construction and subsequent operation – will be incorporated within MHPA's Safety Management System as described under the Port Marine Safety Code (PMSC). NRW PS advise the developer fully engages with local RNLI and HM Coastguard, so that any impacts on Search and Rescue operations and access can be considered. The local Marine and Coast Guard Agency Marine Office should also be engaged with early on, so that local Survey & Inspection operations can be informed. The sections that cover navigational safety under the PMSC and its Guide to Good Practice are within section 7 of the guide which can be found at the following link. https://www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations Section 7.8 of the above report relates to Regulating Harbour Works. NRW PS note that any Aids to Navigation (AtoNs) required will be agreed between Trinity House and Milford Haven Port Authority as the local lighthouse authority for the Area.
22 January 2019	Telecon with MCA	MCA confirmed that radar data / visual data not required to inform the NRA, providing that robust alternatives are demonstrated in the form of wide consultation.
24 January 2019	Email from Irish Ferries	Effects on ferry schedule and services with the twice daily sailings from Pembroke Dock Ferry Terminal. Main issues: Restricted access to Pembroke Dock Ferry Terminal; The narrow Navigable Channel which the Ferry transits, and no other vessel movements permitted during her transit to the berth; Increased activity around Pembroke Dock Waterway, which could incur slow passing of berths, causing delays; Delays to ferry service due weather and the impact any activity would have with this project.
24 January 2019	Email from THLS	If any additional aids to navigation are considered, THLS will need to be consulted and can provide specific advice. THLS would stipulate any aids to navigation in their advice to NRW during the licencing process.

Date	Consultee and type of response	Issues raised
30 January 2019	Stakeholder (Navigation) Workshop	Hobbs Point to East of Cleddau Bridge There is an activity centre at Warrior Way [the Pembrokeshire Performance Sailing Academy, offering dinghy sailing, power boat and shore-based courses], meaning there will be a lot of small vessel activity. Yacht racing occurs at Neyland and Pembroke Yacht Club at Hobbs Point – Wednesday nights and Sunday. Start line uses entire width of the Waterway at Hobbs Point [these races go downstream from the start line which is in line with Neyland marina entrance]. Cruiser racing predominately occurs in daylight hours, 12-20 boats maximum, of 29-35 foot. Kids jumping/swimming across from Hobbs Point Jetty [unofficially]. Small craft training occurs at Warrior Way, and several children may use the slipway at any one time during the Spring/Summer. A dedicated safety boat recovers people (including children) from the water following practice capsize events. Some potting activity and line fishing also occur (predominately recreational).
30 January 2019	Stakeholder (Navigation) Workshop	Dale to Great Castle Head Diving occurs on the wrecks to the south of Great Castle Head. Occasional power boat training. Swimming is generally discouraged in the Waterway, and restricted to sheltered bays (e.g. Dale Bay, Sandy Haven). Some potting for whelks occurs in the vicinity, and there are lots of unmarked fishing buoys. 5/6 fisherman were understood to use the Dale area commercially, with the rocky reef habitats favoured, and a few take out recreational fisherman. 3-4 line fisherman operate from Dale Roads. Small tankers anchor to the western end of the Dale Bay.
30 January 2019	Stakeholder (Navigation) Workshop	Other general points raised: The MHPA regularly patrol the waters May-September. It was noted that there is good management and relationships between recreational users and the port authority, with a designated officer. Activities are generally away from the Port and there is well-established interaction.
22 February 2019	Email from Pembrokeshire Performance Sailing Academy	AIS and RYA data sources are unreliable for the area. Many members of the public use the slipway seasonally at Warrior Way/Cleddau Reach to launch/recover craft (sailing dinghies, powerboats/sportboats, water

Date	Consultee and type of response	Issues raised
		ski/wakeboard users and Personal Watercraft). In addition, PPSA, Llanion Cove and other paddle sports and multi-activity users use the slipway throughout the year. The area is used to train novice sailors and powerboat users.

5 OVERVIEW OF THE MARINE ENVIRONMENT

Pembroke Port is situated within the Milford Haven Estuary (the Waterway). The Port of Milford Haven (A Statutory Harbour Authority covering the entire Waterway and seaward approaches, see **Figure 3**) is a leading UK shipping gateway handling liquid bulk, break bulk, dry bulk and project cargoes. It is known as the UK's largest energy port and is capable of delivering 30% of the UK gas demand.

Pembroke Port operates on a 24-hour basis and has an established reputation for cargo and ferry services. Cargo operations include heavy lifts and environmentally managed cargo, as well as aggregates, animal feed, timber and fertiliser. The Ferry Terminal accommodates a twice daily freight and passenger service to Ireland with capacity to expand. Onsite facilities include storage, laydown and commercial properties.

While leisure users do not use the Port itself as a base, leisure use of the Waterway in the immediate approaches to the port can be intensive, and includes leisure sailing, paddle sports, power boating, organised racing and dinghy training. The Port is not within the Pembrokeshire Coast National Park, but the upper and lower reaches of the Waterway are within the National Park boundaries, encouraging leisure activities and visitors to the whole Waterway.

5.1 METOCEAN CONDITIONS

Pembroke Port is a sheltered port situated within the natural estuary of Milford Haven. It has deep water berths and most vessels have 24-hour tidal access.

A weather station exists at Milford Haven (51°42'N 005°03'W, height 32m Above MSL) where data has been continuously collected and analysed since at least 1980. The weather data is summarised in the UKHO Publication NP37 – Admiralty Sailing Directions – West Coasts of England and Wales Pilot and, therefore, available to mariners using the port.

In summary Milford Haven experiences prevailing south westerly winds, though winds from the north west and south east are not uncommon, with south easterly winds being more common in the mornings from March to June inclusive. NP137 (Section 1.140) gives more detail.

During the period 1980 to 2010, gale force winds were experienced on average 33 days per year, mainly in the period October to March inclusive, and predominantly from a west, to south westerly direction.

The same 30-year period saw fog recorded on 27 days per year, on average (more frequently in the March to July period).

As noted above, the Waterway, and in particular Pembroke Port, are very sheltered, especially from the prevailing South Westerly winds.

5.2 EXISTING VESSEL TRAFFIC MANAGEMENT

Pembroke Port is owned and operated by the Port of Milford Haven, a Trust Port, which is responsible for pilotage and conservancy on the Waterway. The Port is within the Milford Haven Statutory Harbour Authority (SHA) and Competent Harbour Authority (CHA) areas managed by MHPA. Marine risks have been assessed and reviewed on an ongoing basis through procedures included in MHPA's Marine Management System. MHPA provides a Vessel Traffic Service (VTS) actively monitoring the whole Waterway below the Cleddau Bridge.

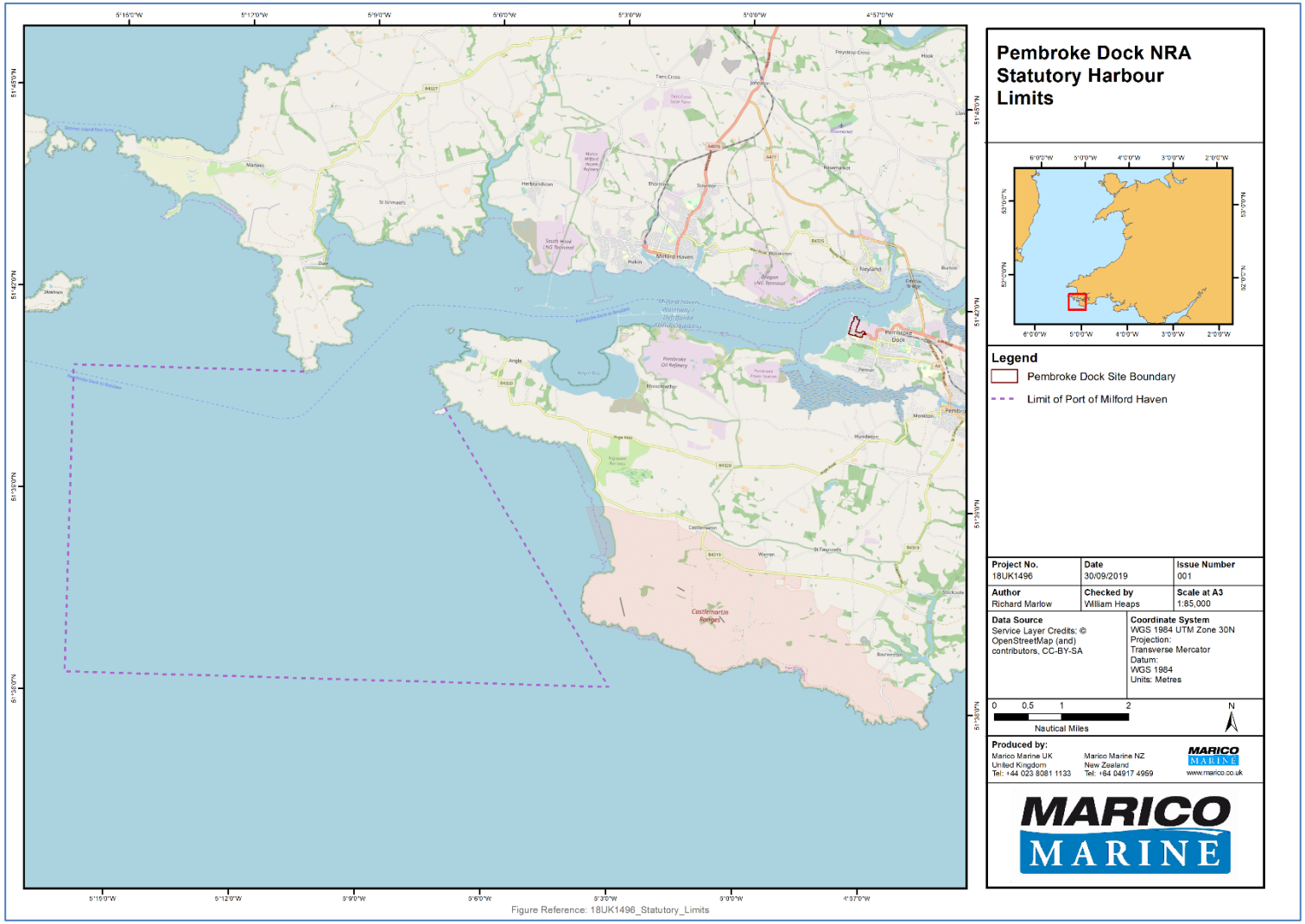


Figure 3: Statutory Harbour Authority Area.

5.3 SEARCH AND RESCUE

Royal National Lifeboat Institution (RNLI) lifeboats are stationed at Angle on the southern shore of the Waterway, south west of the town of Milford Haven. The Angle lifeboat is a Tamar class all weather lifeboat. She is 16.3 m LOA, has a crew of seven, and is capable of 25 knots having a range of 250 nm. In addition, two "D" class inshore lifeboats are based at the station.

Her Majesty's Coastguard (HMCG) helicopter assets are based at St. Athan near Cardiff and Newquay in Cornwall.

Milford Haven Coastguard Operations Centre (CGOC) is the local coastguard base for the region and co-located with the MHPA offices and VTS centre. The 2015 implementation of the Future Coastguard Programme saw a restructuring of the CGOCs and implementation of a new IT system that enabled areas to be monitored and incidents responded to from any CGOC or from the National Maritime Operations Centre (NMOC), near Southampton. Therefore, whilst Milford Haven CGOC would likely manage an incident in the Waterway, it could be managed from elsewhere.

5.4 OTHER MARINE ACTIVITIES

The following marine activities have been identified as currently existing in the study area or may be relevant in the future.

5.4.1 Marine renewable energy installations

There are no existing marine renewable energy installations within the study area or wider Waterway however marine renewable energy development is being encouraged through the Pembroke Dock Marine project (see **Section 9.10**).

5.4.2 Subsea Cables

While no subsea cables are charted immediately adjacent to the port area, chart 3275 (A) does show a "Numerous Disused Cables" annotation in the vicinity of Carr Spit. The long history of the Port as a former naval dockyard gives reasonable cause to suspect that cables will exist, some of which may be uncharted. While this may pose some engineering challenges, the navigational impact is limited to an increased potential for anchor snagging (including by vessels involved in the project and considered under the contact hazard, as a special case).

5.4.3 Anchorages

No formal anchorages exist close to Pembroke Port, and indeed there are explicit anchoring prohibited areas around the wreck north east of the ferry berth. Anchoring is regulated and managed by MHPA port control.

5.4.4 Military Exercise Areas

There are no military exercise areas close to Pembroke Port. A large and active range exists outside the entrance to the Waterway (Castlemartin Firing Range), but this is not relevant to the Pembroke Dock NRA.

5.4.5 Dredging Areas and Spoil Grounds

MHPA carries out maintenance dredging in several areas of the Waterway, chiefly in the main deep-water channel and approaches to the main hydrocarbon jetties and manages dredging activities carried out by port users. Maintenance dredging undertaken by MHPA is carried out under a maintenance dredging licence issued by Natural Resources Wales. There is a licensed maintenance dredge area covering the principal berths in Pembroke Port and their approaches (DML 1666, licence expires 08 March 2022)[1].

Two licensed disposal sites exist in the Milford Haven area – the principal site being outside the entrance to seaward (Milford Haven / St Anns Head), while a small area also exists closer to Pembroke Port towards the Cleddau Bridge (LU 190 “Neyland [off Milford Haven]).

Dredging is managed by MHPA, while licensing of dredge areas and disposal sites are regulated by NRW through licensing / consents.

5.4.6 Leisure Areas

The Waterway as a whole is an important and well used area for all forms of water-based leisure, including activities falling under the traditional definition of navigation such as sailing and motorboat cruising. There are also a wide variety of other activities including paddle sports, sail training, swimming, diving and coasteering. Overall these are well regulated by MHPA in conjunction with the

[1] Source – NRW data portal

National Park Authority, and compliance with rules and regulations is enforced through the on-water presence of the MHPA water ranger, who is afloat throughout the year, but especially during the summer season.

Leisure and other uses of the Waterway are zoned, and clear information is given in the annual Tide Tables & Leisure User Guide[2]. See also **Figure 4.**

[2] See: https://www.mhpa.co.uk/uploads/2019%20documents/PoMH%20Tide%20Tables%202019%20for%20online.pdf

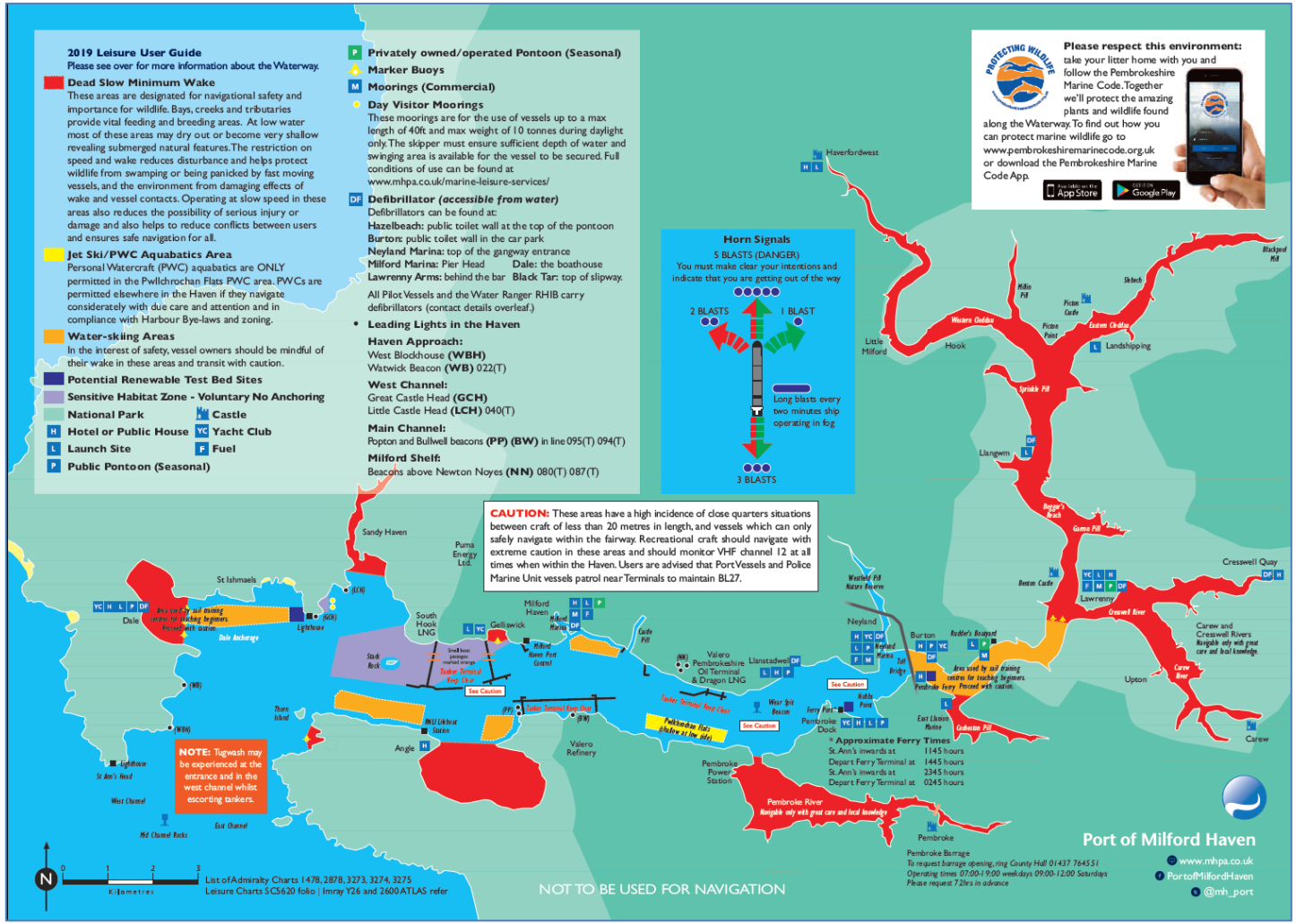


Figure 4: MHPA Leisure User Guide Chartlet.

6 EXISTING VESSEL TRAFFIC AT PEMBROKE PORT

6.1 DATA SOURCES

MCA's MGN 543 requires that *"An up to date, traffic survey of the area concerned should be undertaken within 12 months prior to submission of the Environmental Statement. This should include all the vessel types found in the area and total at least 28 days duration but also take account of seasonal variations in traffic patterns and fishing operations. (Note: AIS data alone will not constitute an appropriate traffic survey)."*

The PMSC is also clear that an NRA should be based on the best available data that accounts for all marine users, not just those equipped with AIS. Typically, this is achieved through a radar and visual traffic survey from shore or from afloat. Given the scale of the project and location entirely within the MHPA SHA area, this approach is not considered proportional for this project.

Following advice from the MCA it has been considered sufficient to obtain and analyse suitable AIS data and support the analysis of that data with wide stakeholder consultation to establish the status of non-AIS equipped traffic.

- Recent AIS data was obtained for the whole Waterway covering winter and summer periods:
  - 01 to 28 February 2018
  - 01 to 28 August 2018
- Additional data sources, over and above stakeholder consultation included:
  - MHPA commercial traffic data;
  - RYA Leisure user intensity mapping (via NRW web portal); and
  - MHPA and Marine Accident Investigation Branch (MAIB) incident data sets.

6.1.1 AIS Derived Vessel Traffic Routes in Milford Haven

Figure 5 shows an overview of AIS reported vessel traffic within the Waterway during the summer months, while **Figure 6** gives a similar overview for the winter period.

Both plots clearly show the intensity of traffic bound for the main commercial berths is consistent in both summer and winter, with the routes to the main hydrocarbon berths (South Hook LNG, Valero refinery on the south bank, and Valero Oil Terminal & Dragon LNG), Milford Haven Dock and Pembroke Port being clearly highlighted in yellow / red on the density plots.

However, the summer plot also demonstrates that much more of the Waterway (i.e. in terms of area) is used by those vessels transmitting AIS data than is the case during the winter – particularly the margins of the Waterway including the approaches to Dale and the reaches above the Cleddau Bridge, and to a lesser extent, Angle Bay and the Pembroke River.

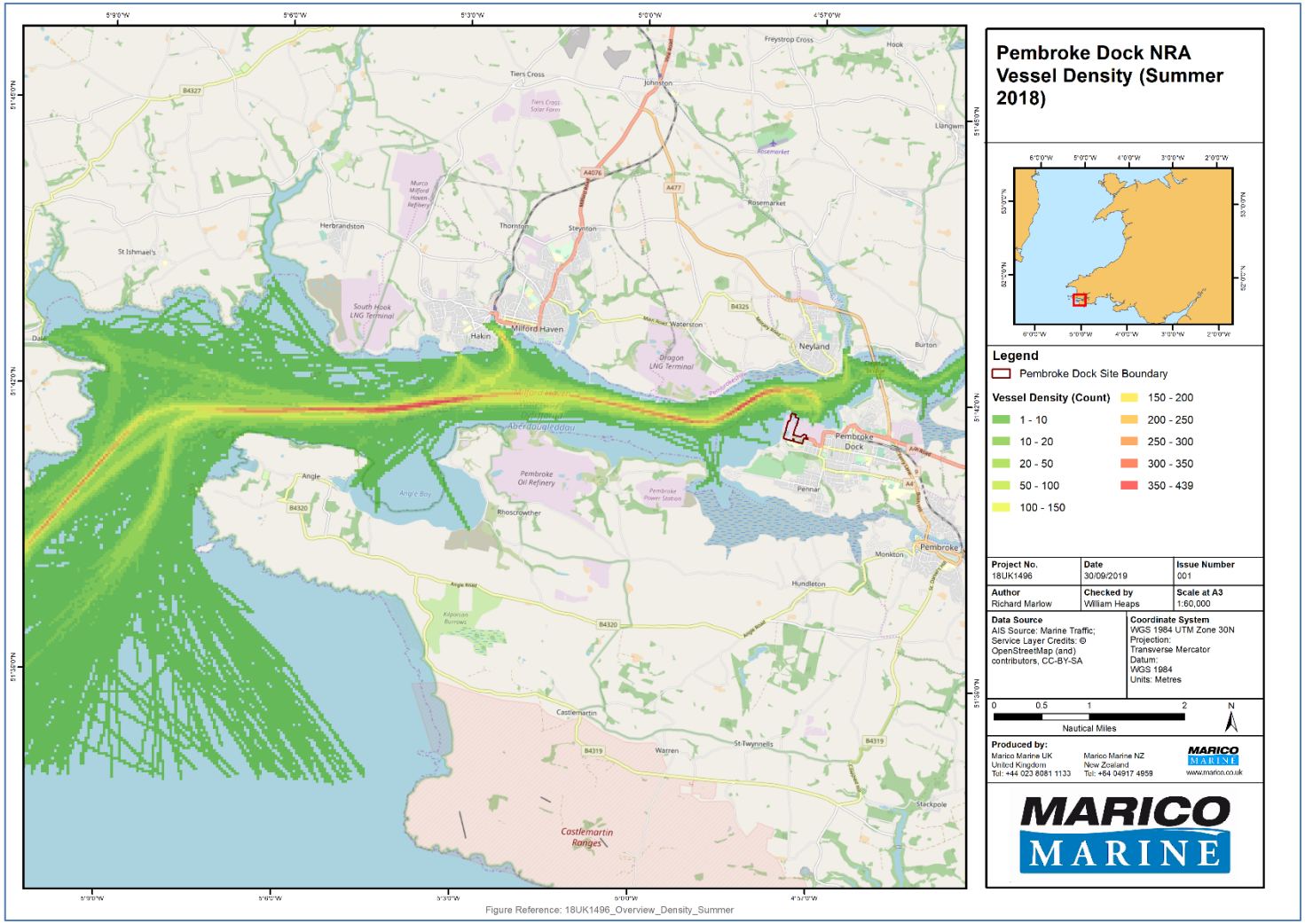


Figure 5: Vessel transit density Milford Haven Waterway (summer).

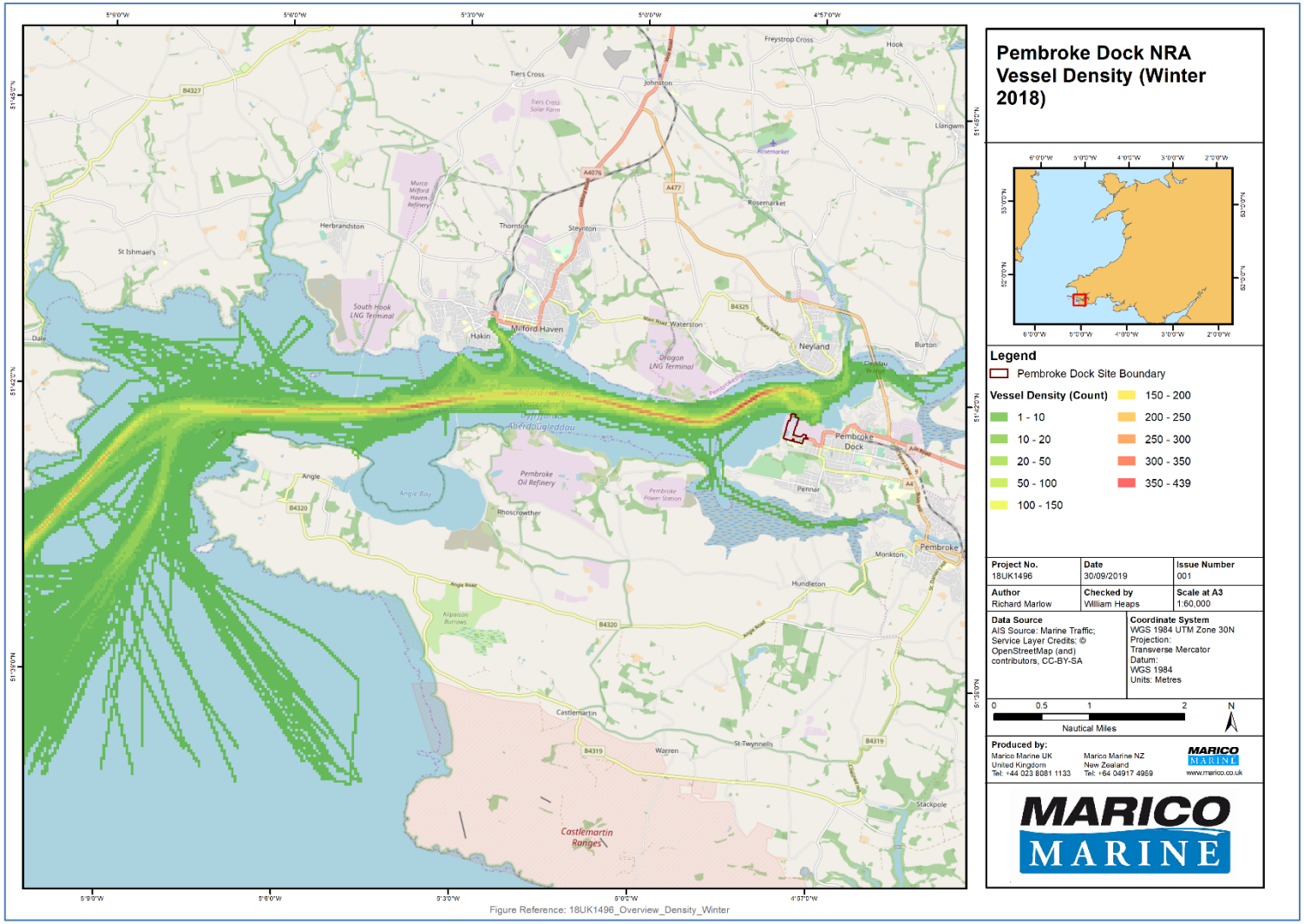


Figure 6: Vessel transit density Milford Haven Waterway (winter).

6.1.2 Other Traffic Data Sources

Recognising that AIS data cannot capture all vessel movements, additional data regarding commercial vessel traffic was obtained from MHPA covering a five-year period (including the periods covered by AIS data) in order to verify the AIS data sets.

Furthermore, Stakeholders (including the MHPA Water Ranger) were consulted to ensure an accurate picture of leisure vessel traffic was established, as it is known that few leisure vessels in Milford Haven are equipped with AIS transmitters (see discussion in **section 6.5**).

6.1.3 MHPA Data

Table 6-1, Figure 7 and **Figure 8** below summarise vessels departing from the named berths in Pembroke Port during the same Winter (February) and Summer (August) periods as illustrated in the AIS data.

These statistics have been extracted from the full vessel movement data records maintained by Port Control at MHPA.

Movements are those vessels departing a berth for any other berth within the Waterway, while sailings are those vessels bound for another port.

Note that the figures below represent departures only, so total vessel movements in each period are approximately double the numbers indicated when arrivals are considered.

It should also be noted that Tug movements are NOT shown in these figures, as routine tug voyages are not recorded on the port data base. See **Section 6.7** for further discussion.

A summary of principal movements is shown in **Table 6-1**. There is no significant difference between winter and summer traffic levels, with the Irish ferry making up the majority of movements, along with departures from berths 1 and 2 on the eastern side of the docks, away from the project site.

Table 6-1: Summary of vessel departures from Pembroke Dock.

	Carr Jetty Long Arm	Mainstay Marine Wet Berth	PDFT	POP No 1	POP No 2	POP No 3	Grand Total
Winter	1	4	58	7	19	2	**91**
Summer	2	1	58	5	15	2	**83**

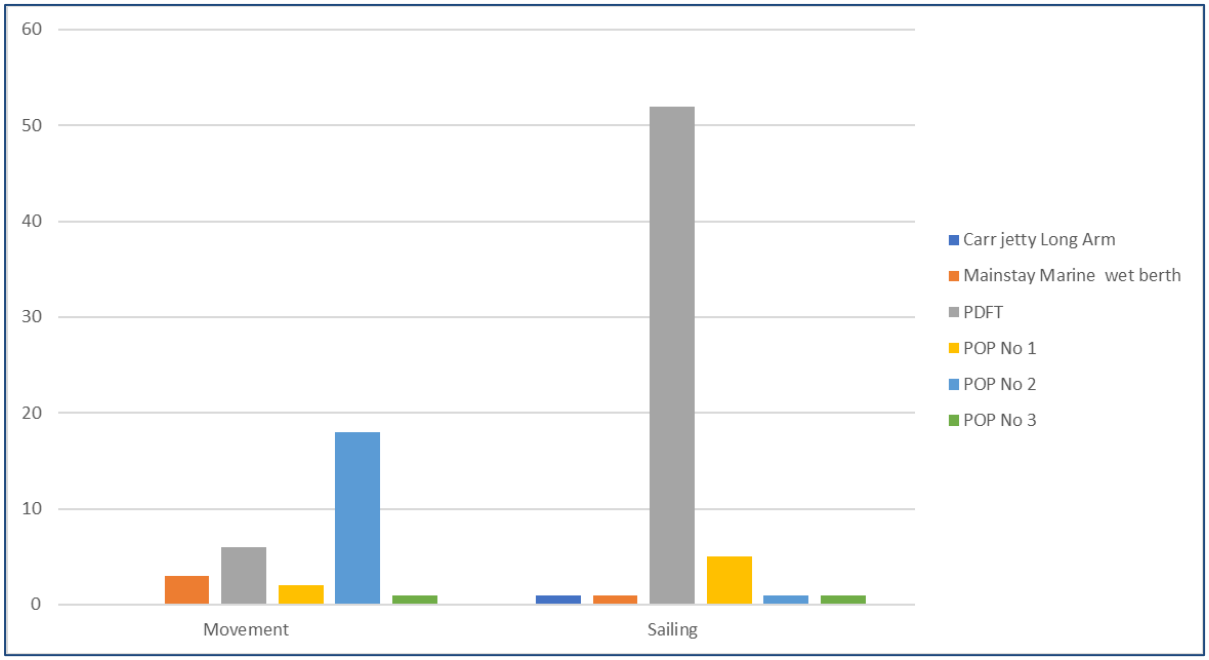


Figure 7: Departures (movements and sailings) from Pembroke Dock Berths (February 2018).

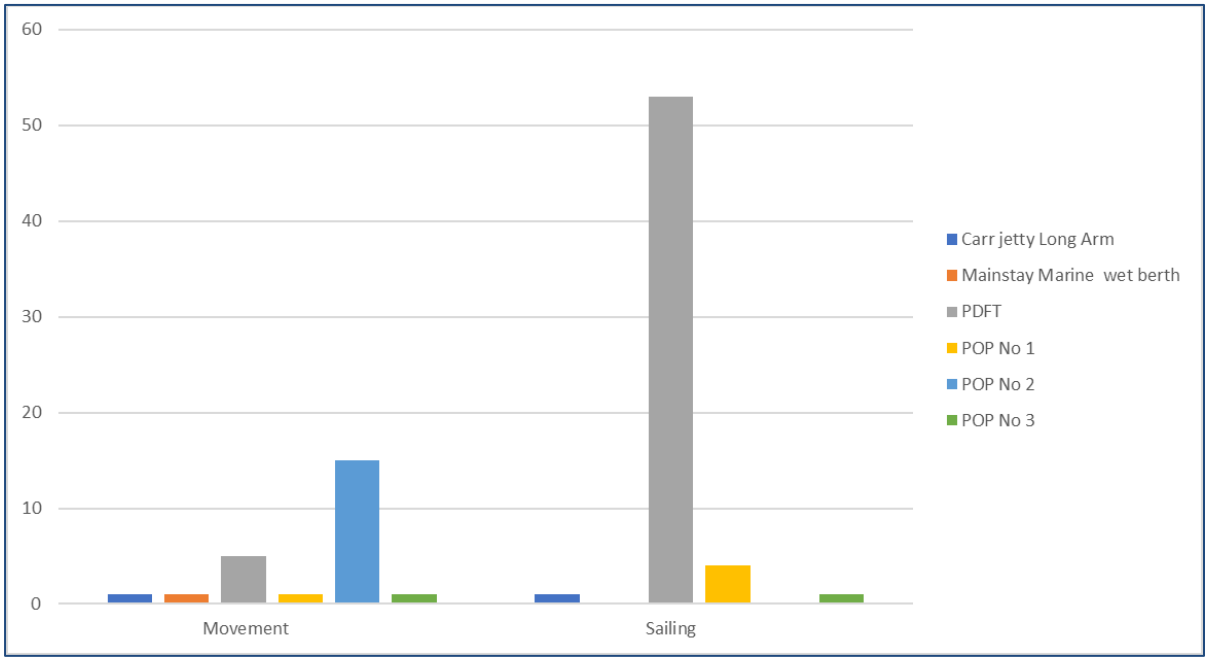


Figure 8: Departures (movements and sailings) from Pembroke Dock Berths (August 2018).

6.1.4 Stakeholder Information

See **Section 4** for details of organisations consulted. Many of these stakeholders were able to give detailed information on local traffic patterns, which has been considered in the individual paragraphs below. However, in the case of Pembroke Port, it was confirmed that most traffic was commercial

near the proposed redevelopment, although leisure use and other non-port-related traffic was significant in the approaches to the port, especially in the summer months.

MHPA publishes a widely distributed and consulted annual Leisure User Guide[3] (and tide tables), in addition to directions and passage planning documents for commercial traffic.

The leisure guide includes a useful diagram (**Figure 4**) which identifies three specific areas where traffic density is high, and in which there is a high incidence of "close quarters situations". One such caution area is to the north of Dockyard Bank close to the redevelopment project.

[3] https://www.mhpa.co.uk/uploads/2019%20documents/PoMH%20Tide%20Tables%202019%20for%20online.pdf

6.2 COMMERCIAL VESSELS (TANKER / GENERAL CARGO)

General commercial vessels in the vicinity of Pembroke Port can be sub-classified as Tankers and General Cargo. AIS tracks for these vessel classes are shown in **Figure 9** and **Figure 10** below. With few exceptions, these tracks show that general commercial vessels are bound for the Eastern berths (POP1 and POP2) in the docks and approach from the north around Dockyard Bank. All such movements will be regulated by port control and are unlikely to directly interact with the development phase of PDI, or future traffic movements close to the newly developed facilities.

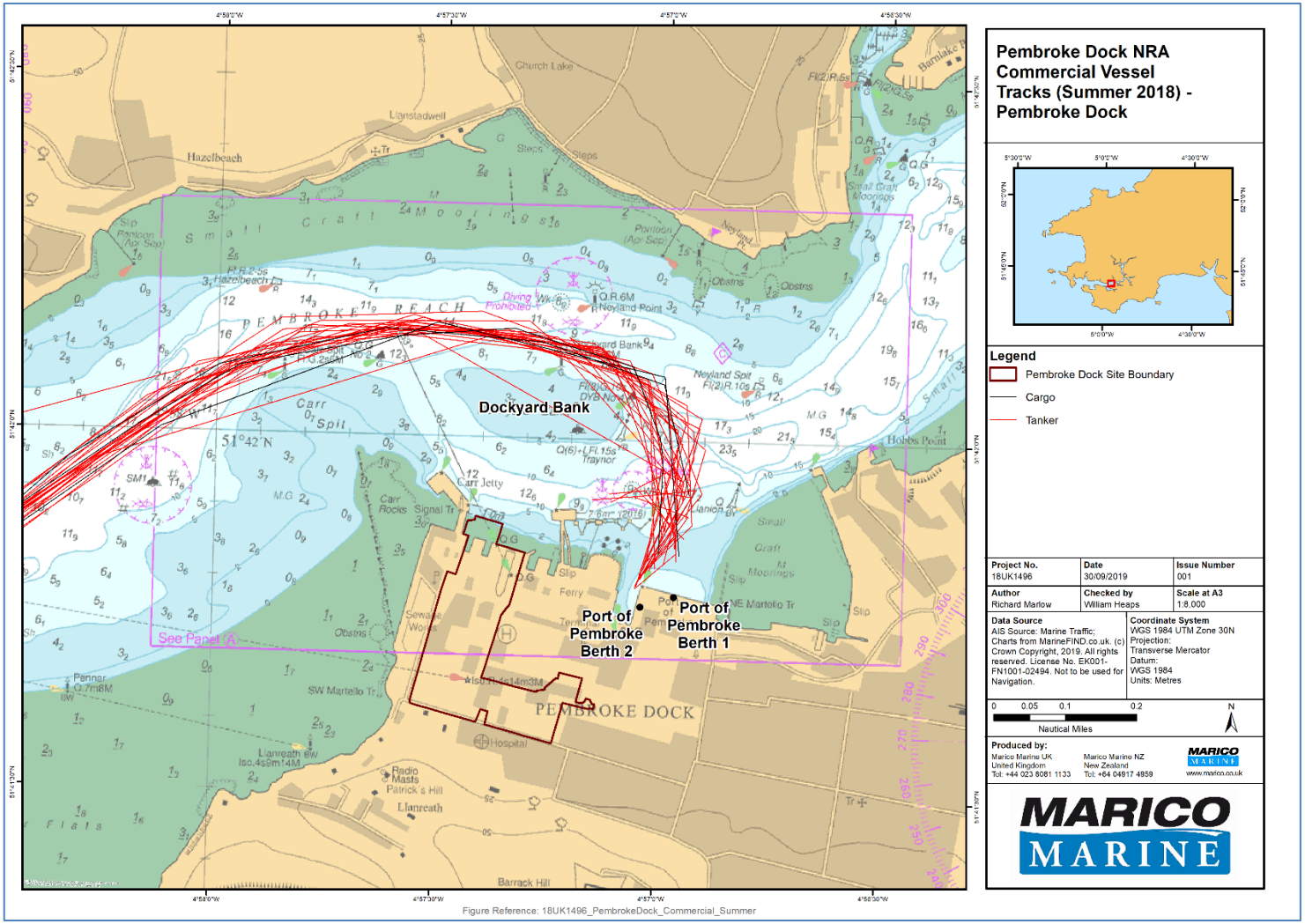


Figure Reference: 18UK1496_PembrokeDock_Commercial_Summer

Figure 9: Commercial Vessel Transits (summer).

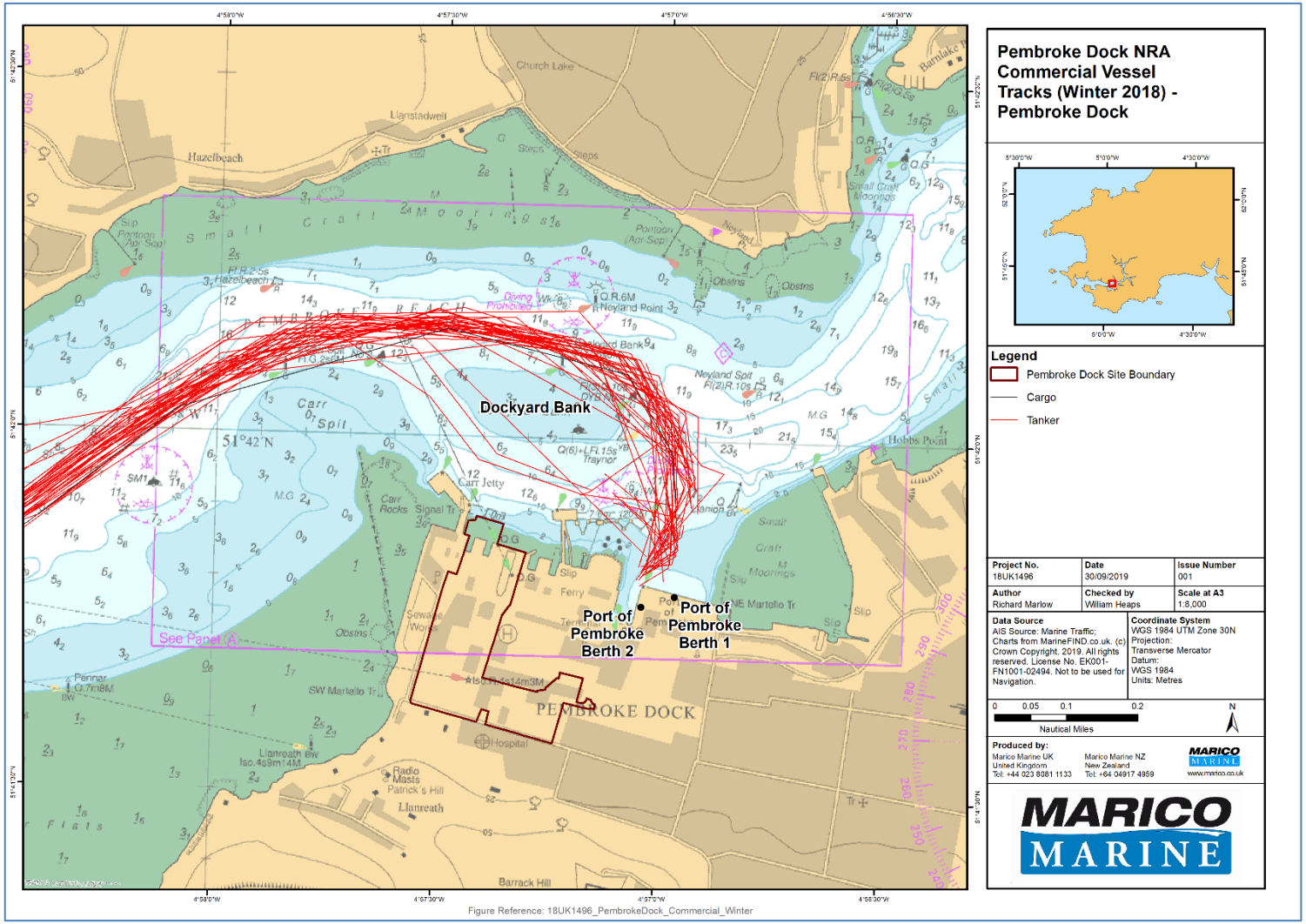


Figure 10: Commercial vessel transits (winter).

6.3 PASSENGER VESSELS

Pembroke Port is an important ferry port for southern Irish Sea passenger and freight traffic. There are routinely two departures / arrivals per day (same vessel) on the normal timetable (around midday and midnight). The density of this traffic, and normal route taken (north of Dockyard Bank and on the berth at PDFT) is clearly visible in **Figure 11** and **Figure 12** below.

Additional passenger vessel AIS tracks are recorded, notably to and from Neyland during both seasons. During the summer months, additional tracks are plotted, for example towards the upper Waterway, and some further south, but once again there are few movements close to the PDI project area.

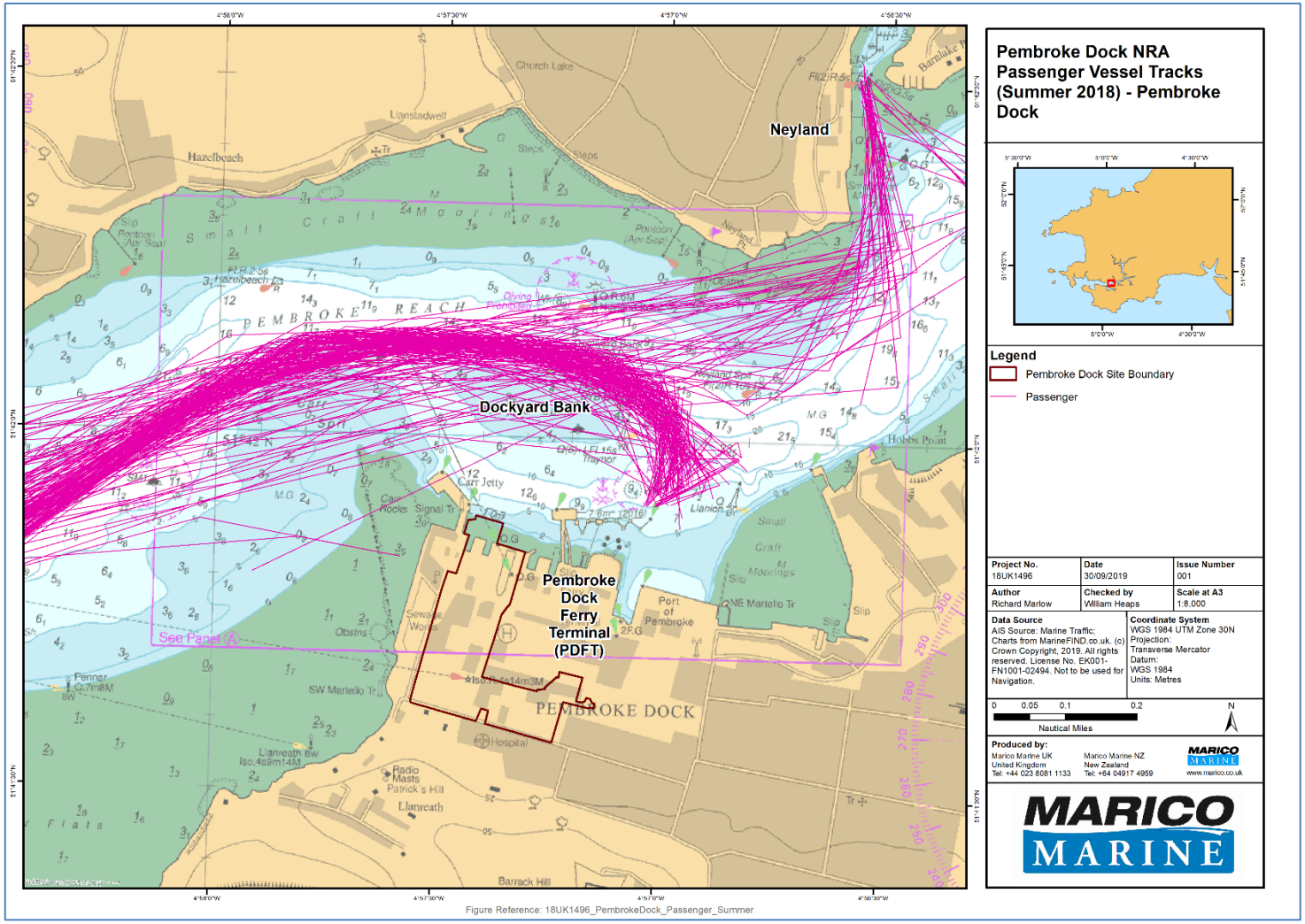


Figure 11: Passenger vessel transits (summer).

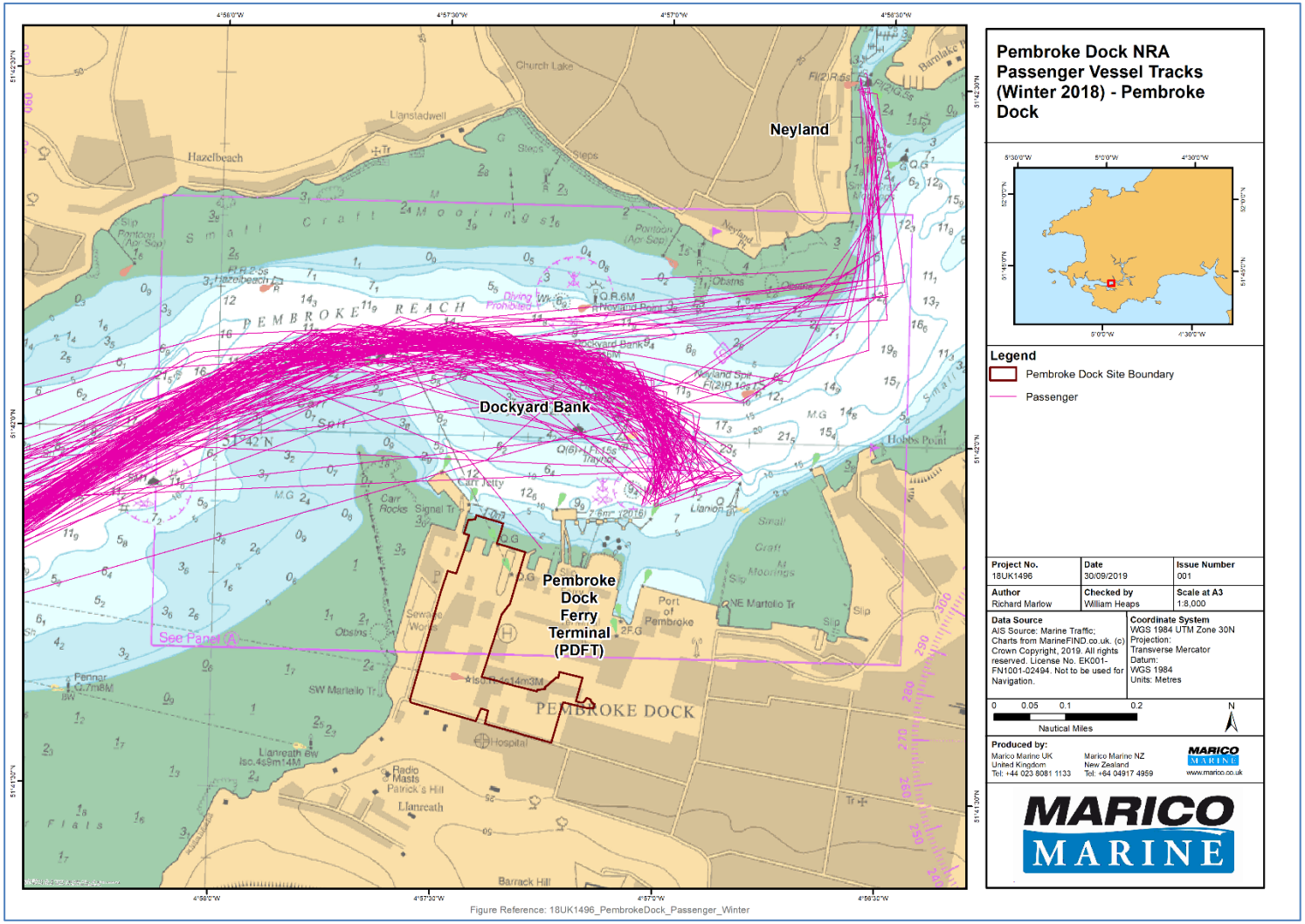


Figure Reference: 18UK1496_PembrokeDock_Passenger_Winter

Figure 12: Passenger vessel transits (winter).

6.4 FISHING VESSELS

Fishing vessel movements are minimal in the study area, with a small number of AIS tracks recorded in the winter period, and none in the summer. This concurs with stakeholder feedback, and the fact that the main fishing port in the Waterway is Milford Haven Docks, to seaward of Pembroke Port.

Fishing vessel traffic is not considered significant to this study.

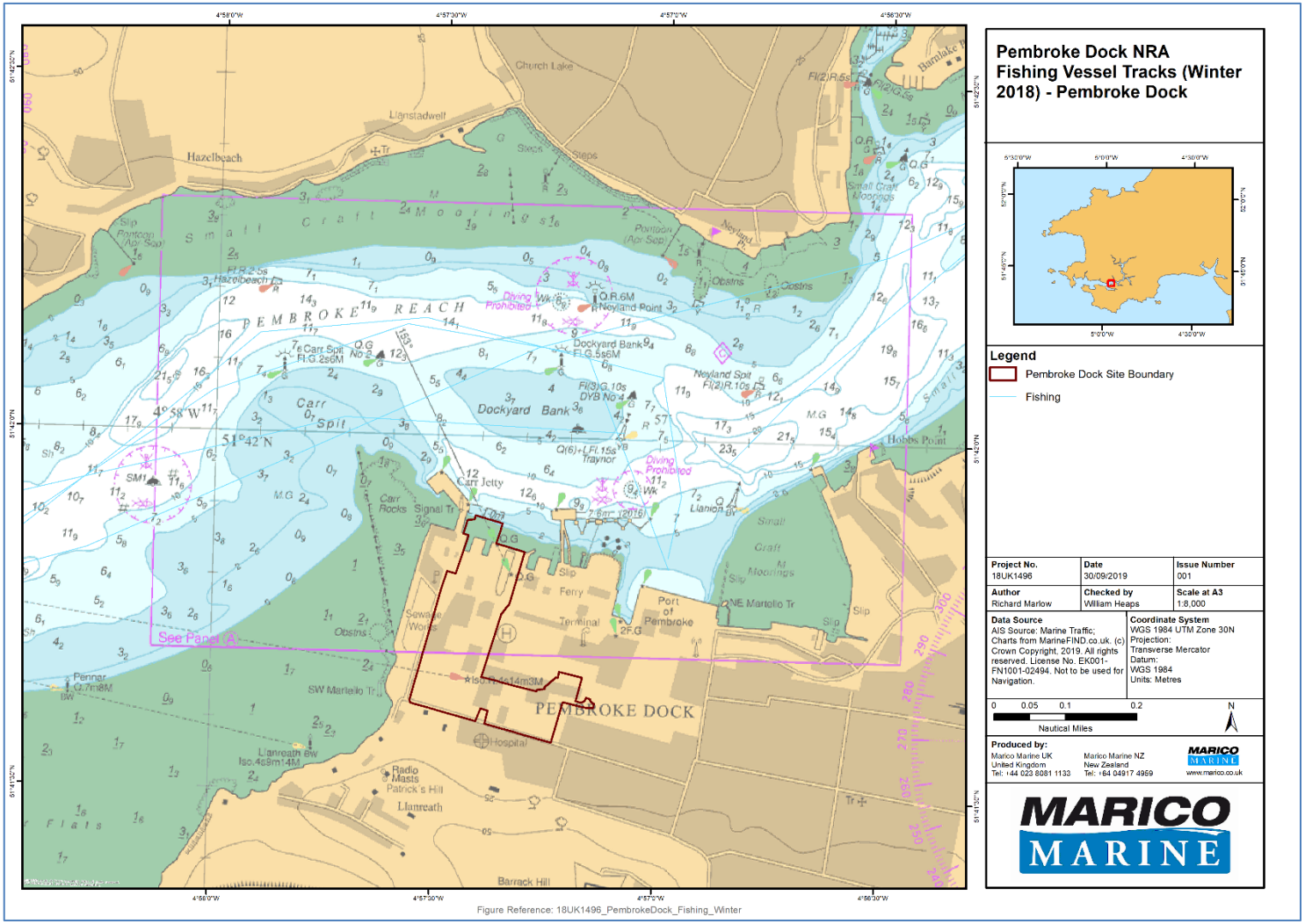


Figure 13: Fishing vessel transits (winter).

6.5 RECREATIONAL CRAFT

Most leisure vessels in the Waterway are unlikely to transmit AIS data. Nevertheless, numerous tracks were recorded in the summer, mainly transiting between Neyland and the seaward end of the Waterway. Most of these are likely to be larger vessels, and probably semi-commercial in nature. There were no recorded leisure AIS tracks in the winter period.

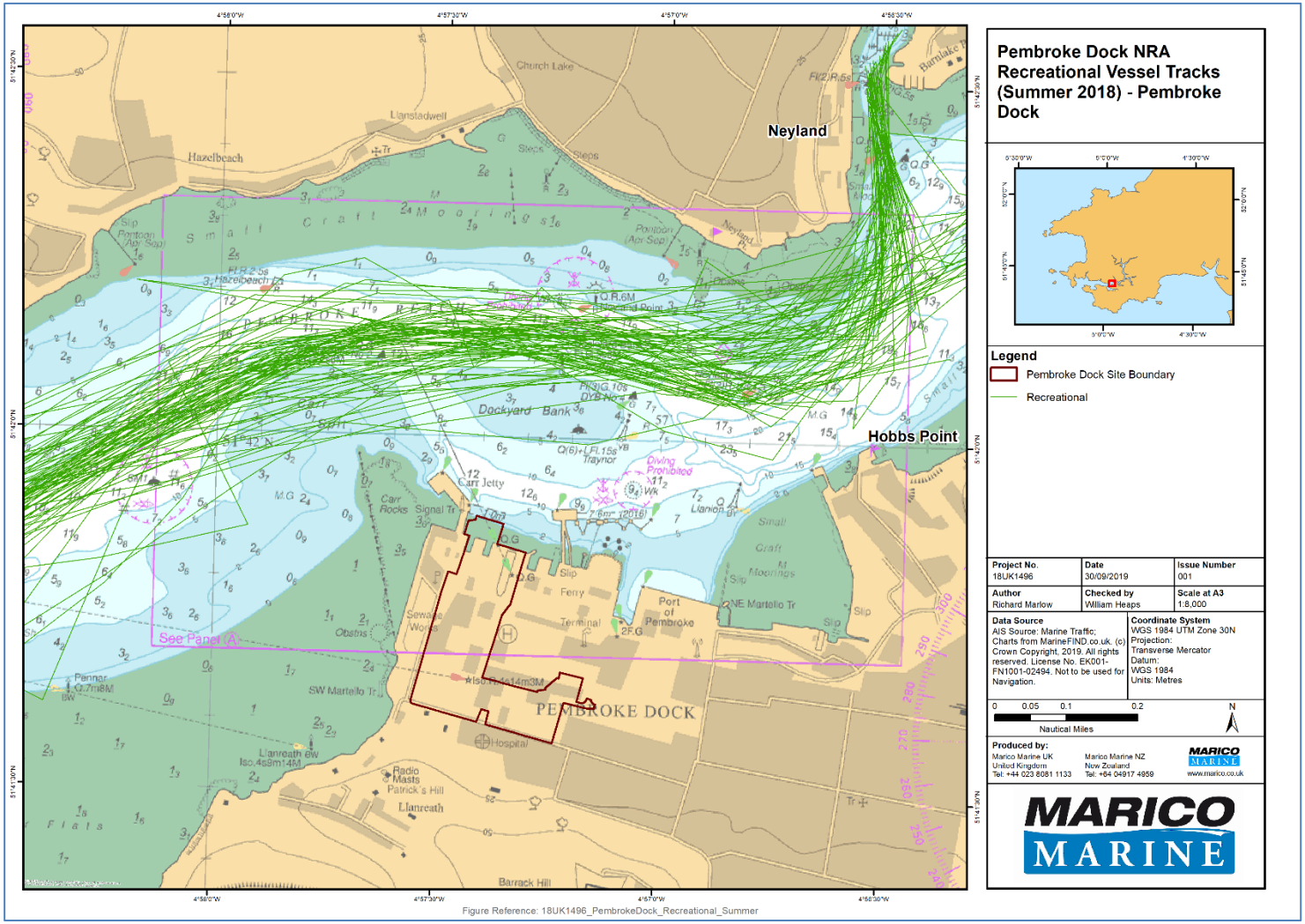


Figure 14: Recreational vessel transits (summer)

Stakeholder consultation confirmed that leisure vessels on passage are likely to follow similar tracks to those indicated in **Figure 14** above (Neyland to seaward). However, there is also intensive usage of the Waterway by local vessels, e.g. dinghy and small yacht cruising, racing (especially in the area near Hobbs Point), (youth) sail training, canoeing and other paddle sports, and support vessels for all of the above activities. While there is no numerical data available for these vessel tracks, stakeholders agreed that the RYA intensity data available from the Wales Marine Planning Portal (though based on AIS) broadly gives a realistic illustration of leisure vessel intensity in the Waterway. Although the RYA intensity data indicates very high leisure usage in the Pembroke Port reach of the Waterway, stakeholders confirmed that there is normally little interaction with the docks and berths themselves, with leisure mariners choosing to avoid conflict with larger commercial traffic. Leisure vessel traffic is concentrated in the summer months, and very much reduced in the winter.

6.6 HIGH SPEED CRAFT

Tracks of High-Speed Craft were identified in both the summer and winter datasets, and once again these are mainly between Neyland and the seaward approaches. It is likely such vessels may include small commercial RHIBs and some motorised leisure vessels as AIS categorisation is not perfect. This may explain why some vessels appear to take short cuts over the Dockyard Bank and approach closer to the Pembroke Port berths.

None of the recorded tracks appear to indicate Pembroke Port as a destination, although it is known that occasional wind farm crew transfer vessels (high speed “windcats”) do visit the port for maintenance and other purposes. However, on such voyages they will be subject to port control directions, and unlikely to be travelling at operational speeds.

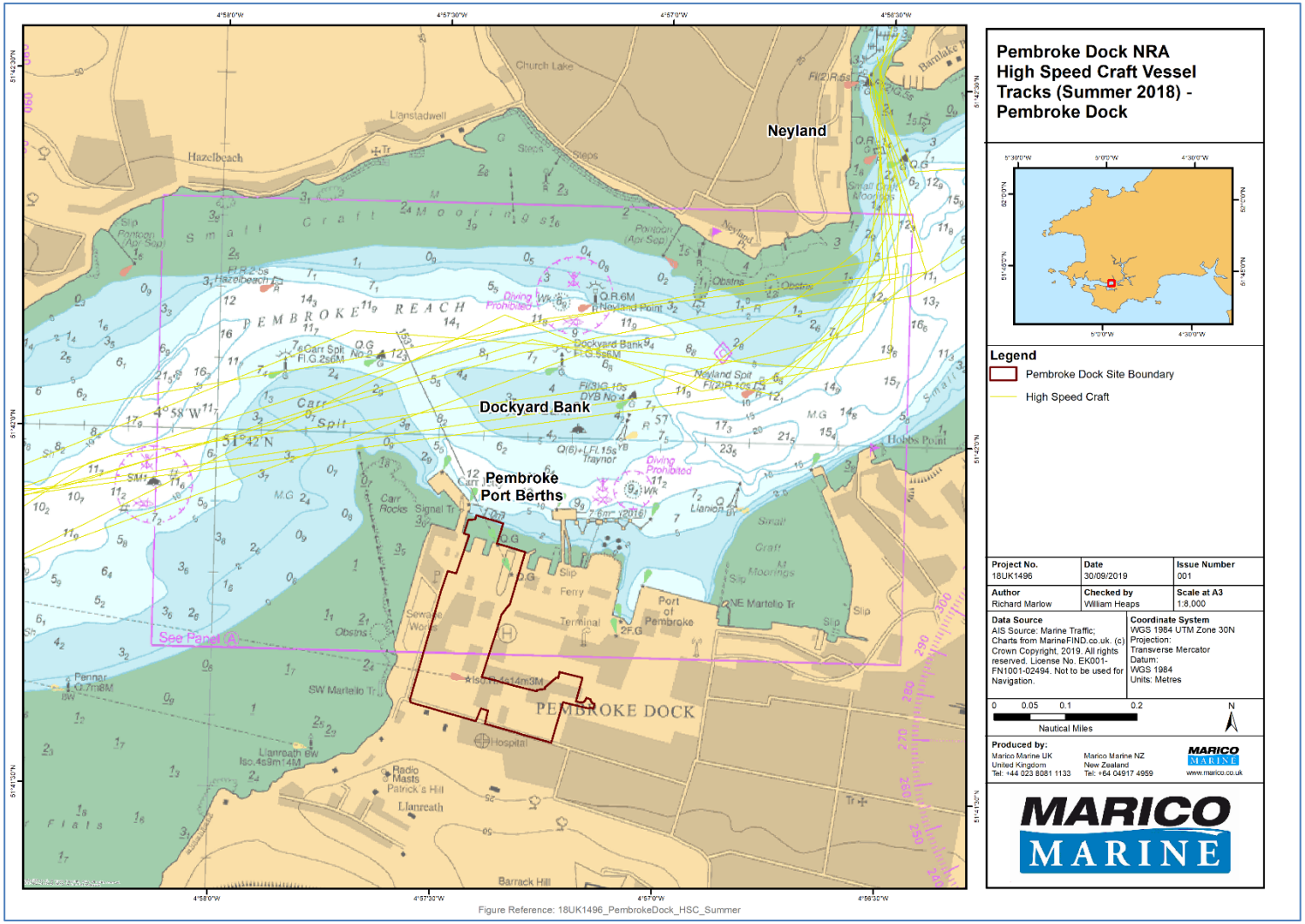


Figure 15: High Speed Craft transits (summer).

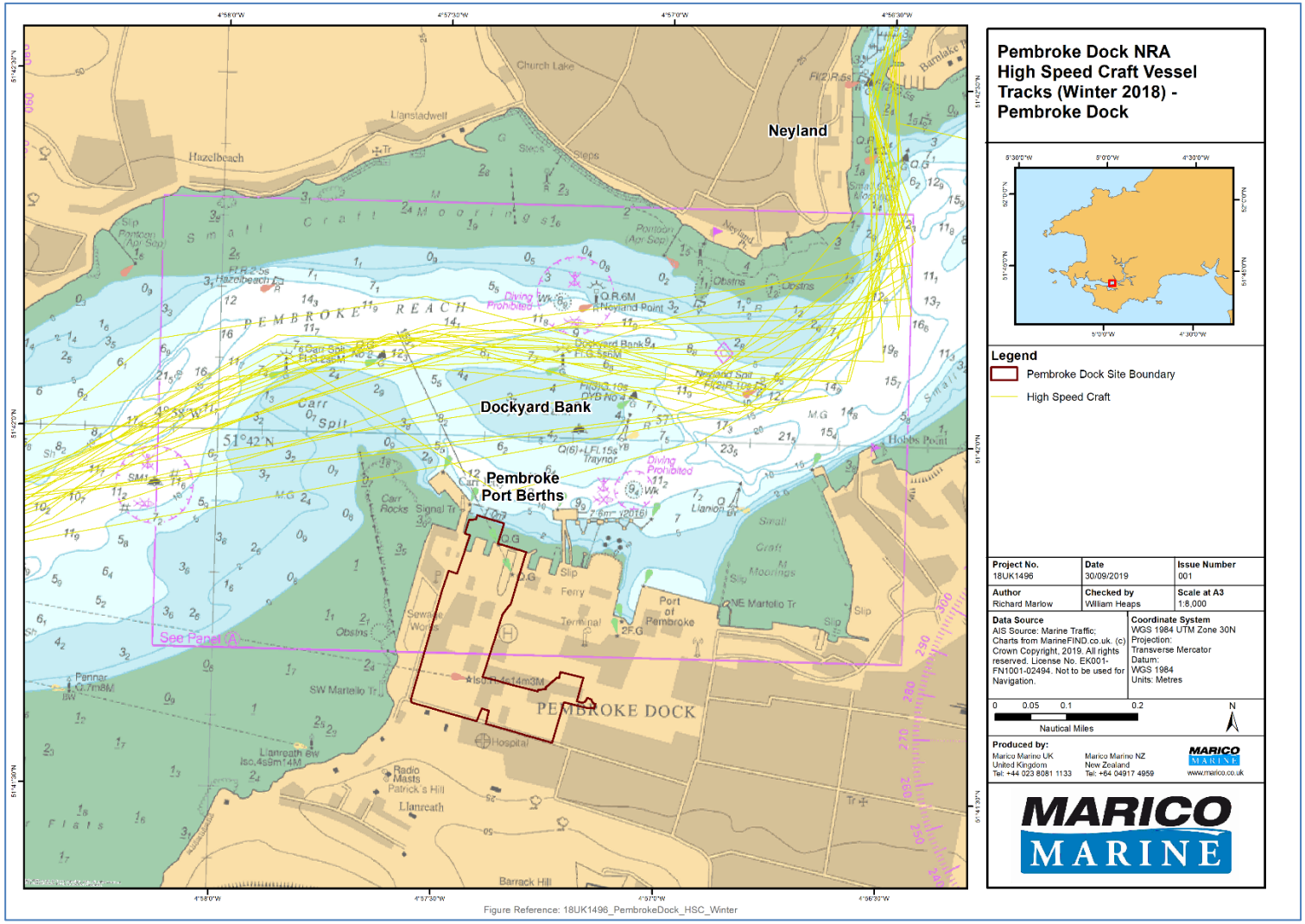


Figure Reference: 18UK1496_PembrokeDock_HSC_Winter

Figure 16: High Speed Craft transits (winter).

6.7 TUGS AND OTHER SERVICE VESSELS

This class of vessel is the most commonly recorded in close proximity to the project site. These tracks largely represent harbour towage tugs which are based at Carr Jetty (and sometimes the Ferry Terminal) and make very regular movements escorting vessels in and out of all areas of the port. These movements are not represented in the MHPA traffic data discussed in **section 6.1.3**.

Despite the frequency of vessel movements recorded in both seasons (there is little seasonal difference), all these vessels are highly manoeuvrable, and have very experienced crews with excellent local knowledge.

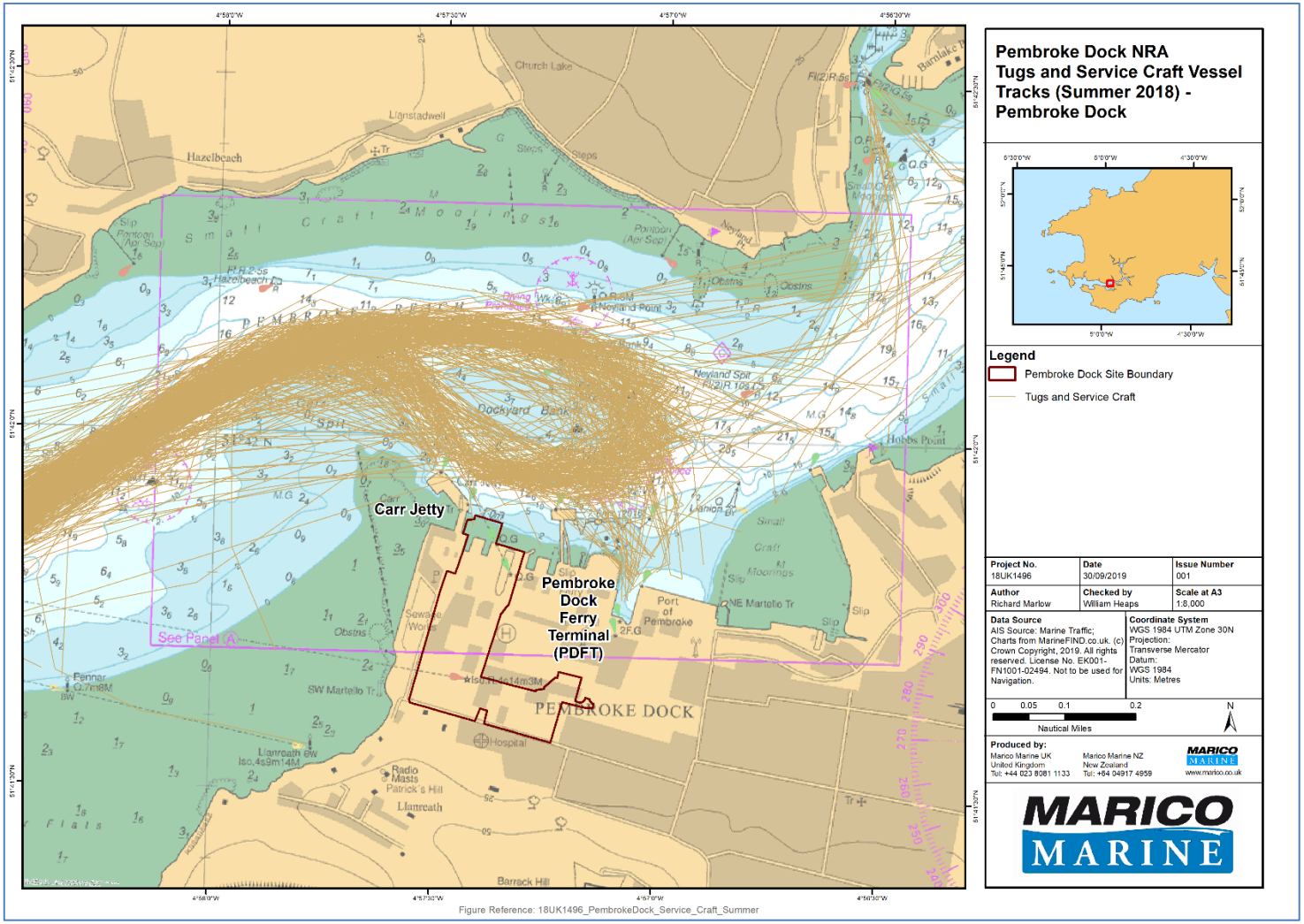


Figure 17: Tug and Service vessel transits (summer).

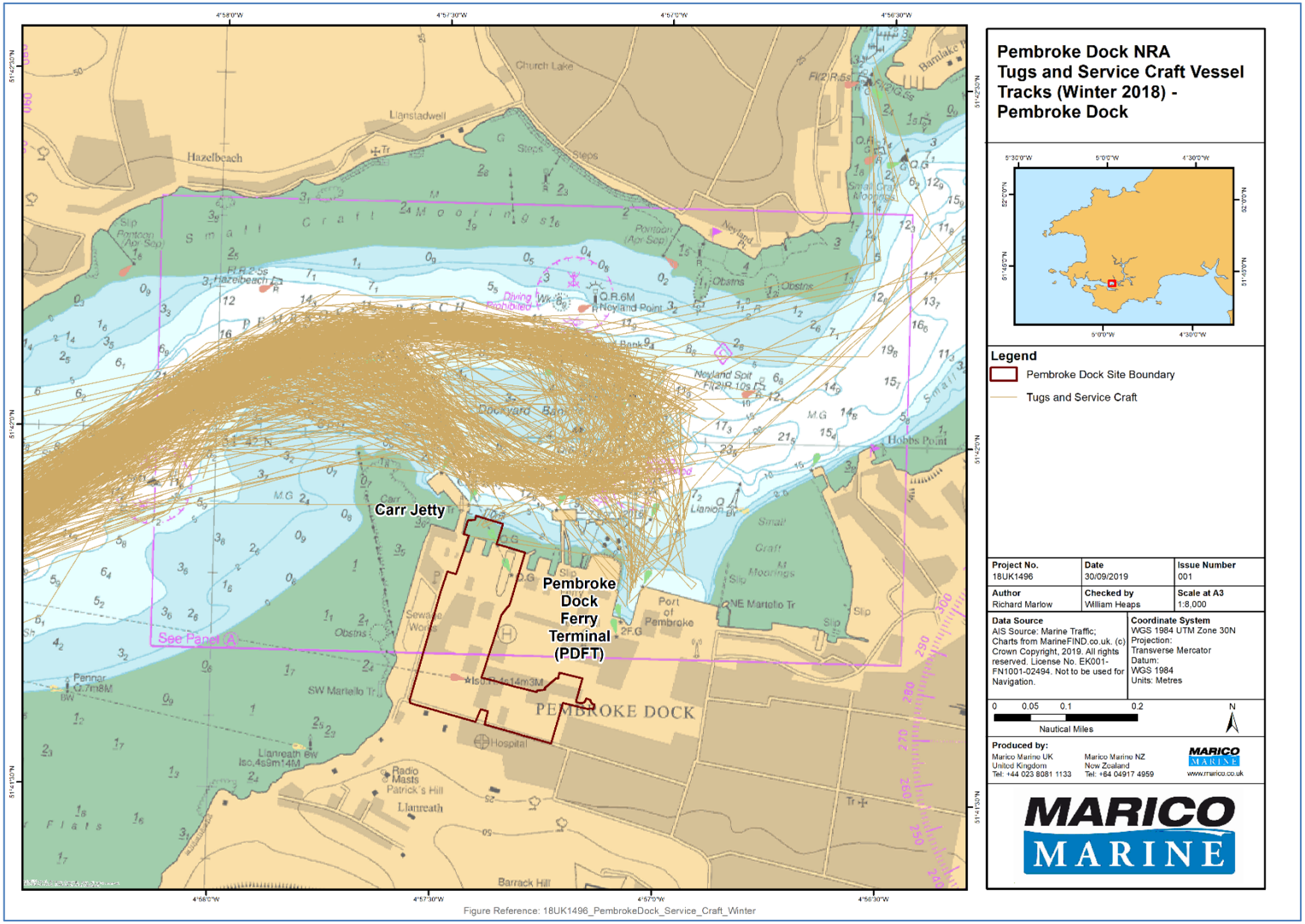


Figure 18: Tug and Service vessel transits (winter).

7 HISTORICAL INCIDENTS

Analysis of historical incident data provides a secure basis for assessing likely future incident frequency. The principal sources of incident data for Milford Haven are the MAIB and the Port Authority's own records. Both sources of data have been verified through the stakeholder consultation exercise.

7.1 MAIB REPORTABLE INCIDENTS

An analysis of MAIB incidents between 1997 and 2017 was conducted, with some 183 incidents being identified in the Milford Haven area as shown in **Figure 19**.

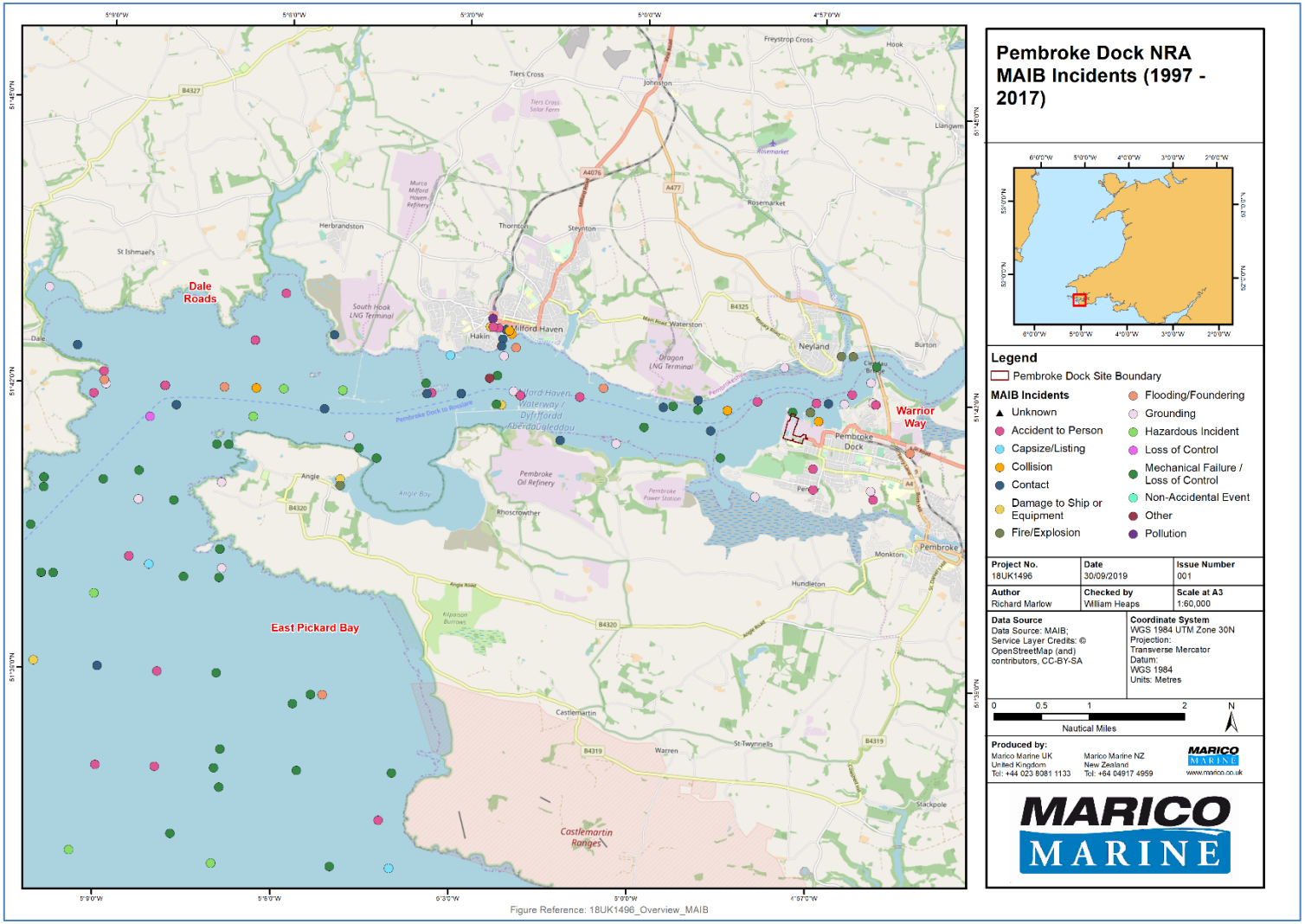


Figure 19: MAIB Incidents between 1997-2017.

During the period for which records are available (1 January 1997 to 1 September 2017) the total number of incidents categorised by the primary event cause were as shown in **Figure 20**.

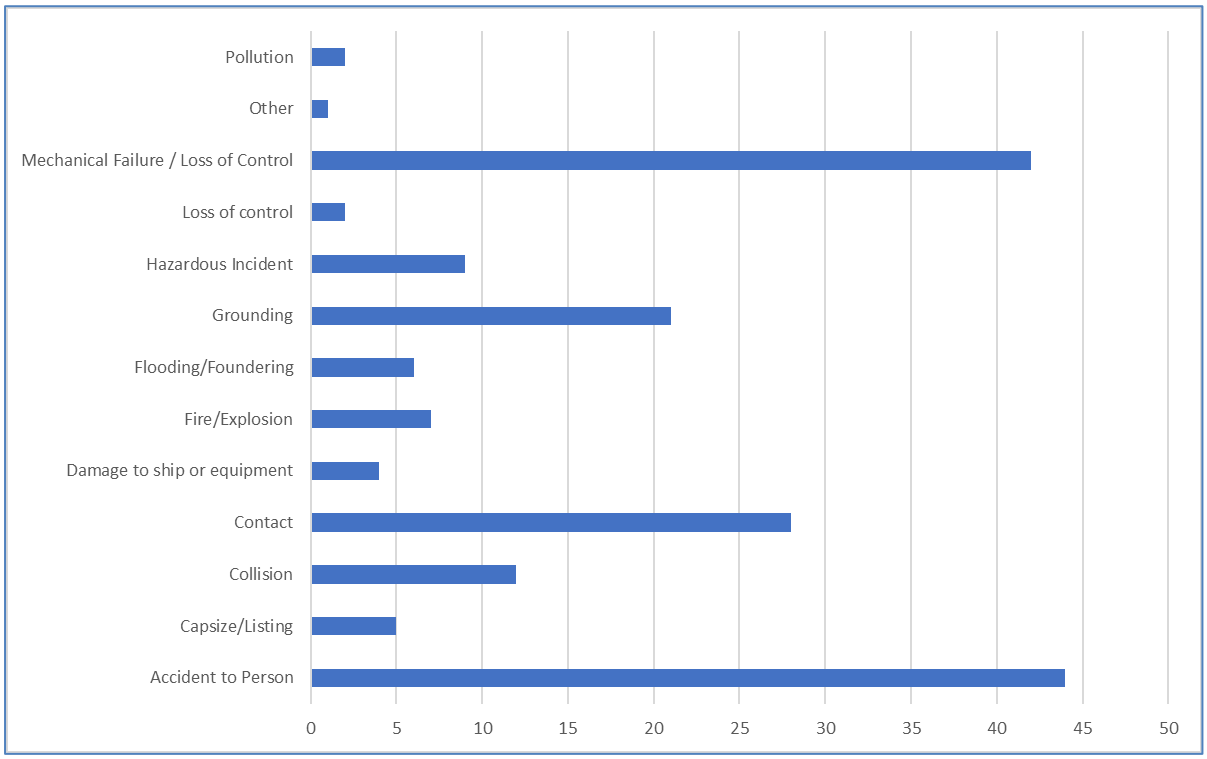


Figure 20: Primary Incident Cause: 1997 – 2017.

Since new casualty reporting regulations were introduced in 2012[4], the MAIB has also categorised incident severity, and this data is illustrated for all incidents recorded since June 2012 in **Figure 21**.

A *marine casualty* is an event or sequence of events that occurred directly in connection with the operation of a ship, and resulted in:

- The death of, or serious injury to, a person;
- The loss of a person from a ship;
- The loss, presumed loss or abandonment of a ship;
- Material damage to a ship;
- The ship being unfit to proceed or requires flag state approval or a condition of class before it may proceed;
- At sea, a breakdown of the ship, requiring towage;

[4] MGN 564, MAIB, October 2012

- The stranding or disabling of a ship, or the involvement of a ship in a collision;
- Material damage to marine infrastructure external of a ship that could seriously endanger the safety of the ship, another ship or any individual; and
- Pollution caused by damage to a ship or ships.

A *marine incident* means an event, or sequence of events, which occurred directly in connection with the operation of a ship, that do not meet the criteria to be classified as a marine casualty but that endangered or, if not corrected would endanger, the safety of the ship, its occupants or any other person or the environment (i.e. a near miss).

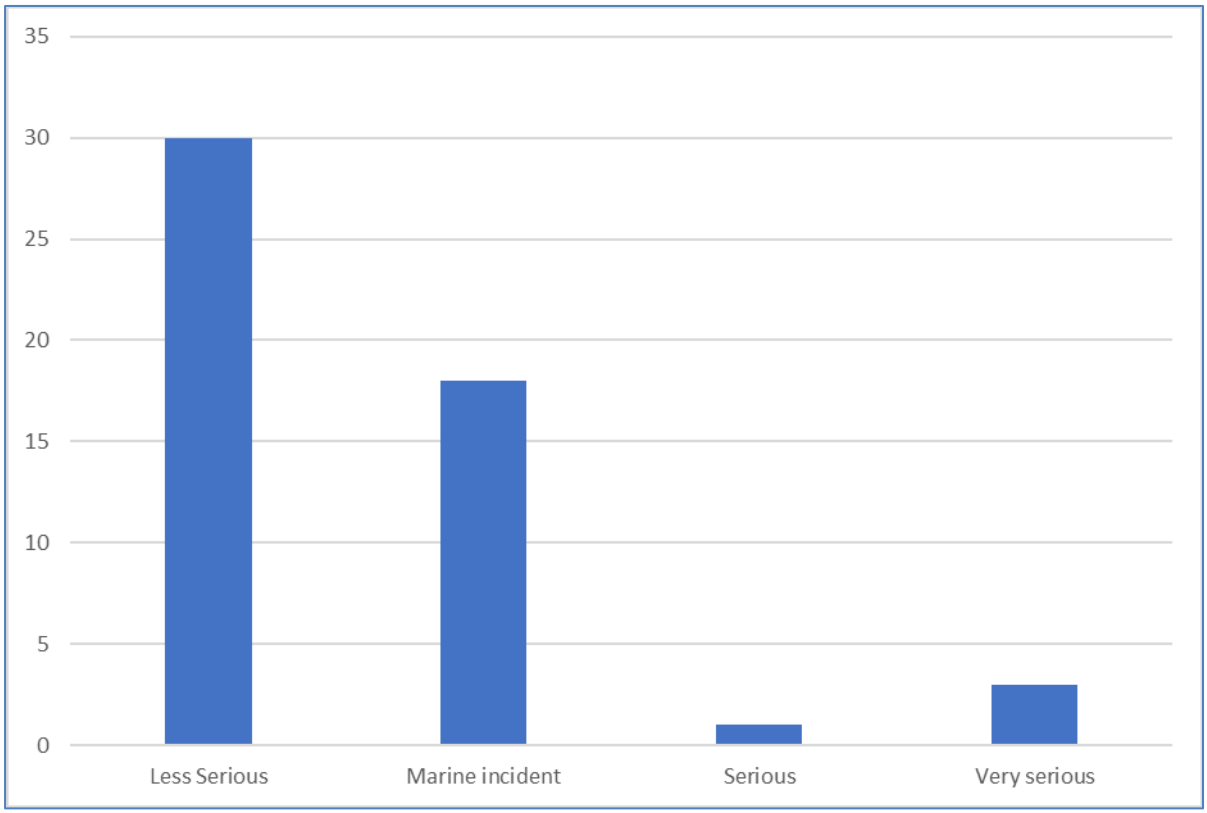


Figure 21: Incident Severity (Since June 2012).

Most of these statistics will relate to large commercial vessel movements and this is illustrated by the geographical spread of incidents shown in **Figure 19,** with many being concentrated in the deep-water channel and harbour approaches (many of the latter being mechanical failures reported by pilots).

The majority of incidents (since classification began) have been 'less serious' or 'marine incidents' (near misses). Incidents involving small vessels (only), especially leisure craft, are unlikely to be represented in MAIB statistics due to lack of reporting. However, stakeholder consultation confirmed that incidents involving small craft rarely resulted in significant damage or injuries.

The seven incidents occurring close to Pembroke Port are summarised in **Table 7-1.**

Table 7-1: MAIB Incidents in Approaches to Pembroke Port.

Date of Casualty	Nature of Occurrence	Primary Cause
02/11/1998	Accident	Grounding
04/05/1999	Accident	Fire/Explosion
31/03/2000	Accident to Person	Accident to Person
07/12/2006	Accident	Contact
11/04/2007	Accident	Mechanical Failure / Loss of Control
30/07/2008	Accident	Fire/Explosion
29/08/2015	Casualty with a ship	Collision

7.2 MILFORD HAVEN PORT AUTHORITY INCIDENTS

Incident data was received from MHPA covering the calendar years 2013 to 2018. Unfortunately, it proved difficult to extract precise locations of incidents, due to the way the data had been recorded; however, useful analysis could be performed to inform assessment of how frequently certain hazards had occurred and thus inform the risk assessment process.

At a broad level, it can be seen (**Figure 22**) that the overall number of marine events (divided into incidents and near misses) have increased over the last six years, but the number of incidents has been increasing more slowly than the number of near misses. This is likely a reflection of an industry wide campaign to capture more incident reports, and especially to encourage near miss reporting in recent years.

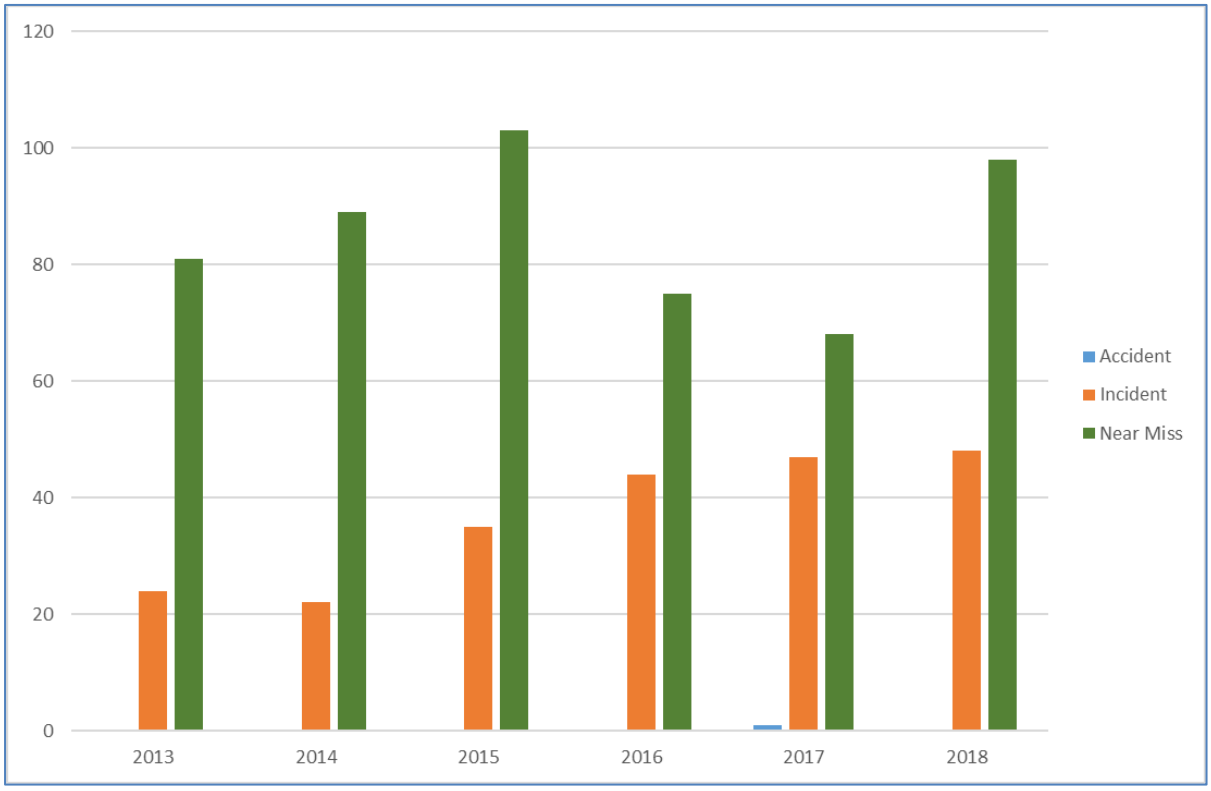


Figure 22: Incident and Near Miss Reports 2013-2018.

If the same data is reviewed on a seasonal basis (**Figure 23**) it is apparent that, in general, more incident and near miss reports are recorded in Q3 (approximating to summer) than Q1 (winter). This reflects the greater leisure traffic densities during the summer as discussed in **Section 6** of this report.

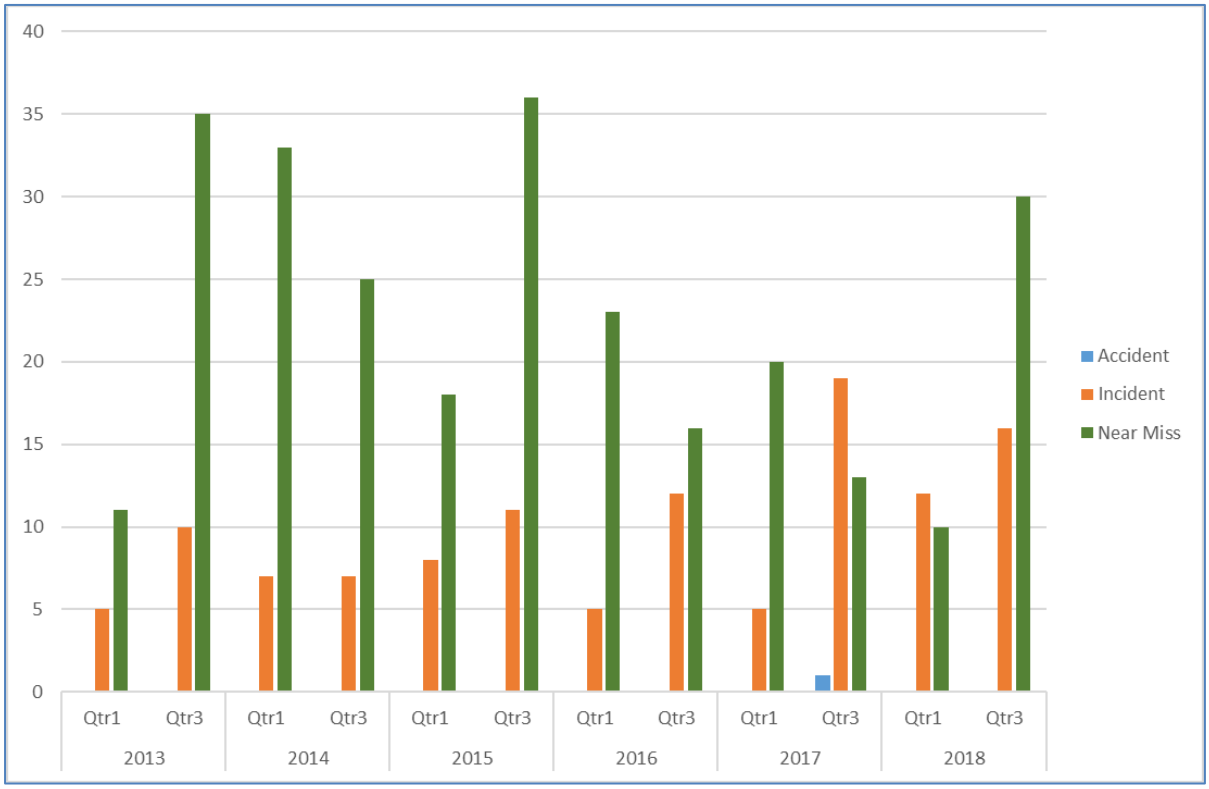


Figure 23: Incident Reports by Season.

Incidents for the most recent data (2018) were analysed by category. **Figure 24** shows the number of incidents that occurred by selected category (these categories broadly correspond to the hazards identified for the Pembroke Dock Marine assessments in **Section 10.2.4**). It is noted that Engine / machinery failure should more correctly be considered a cause rather than a hazard but could contribute to the other hazards developing).

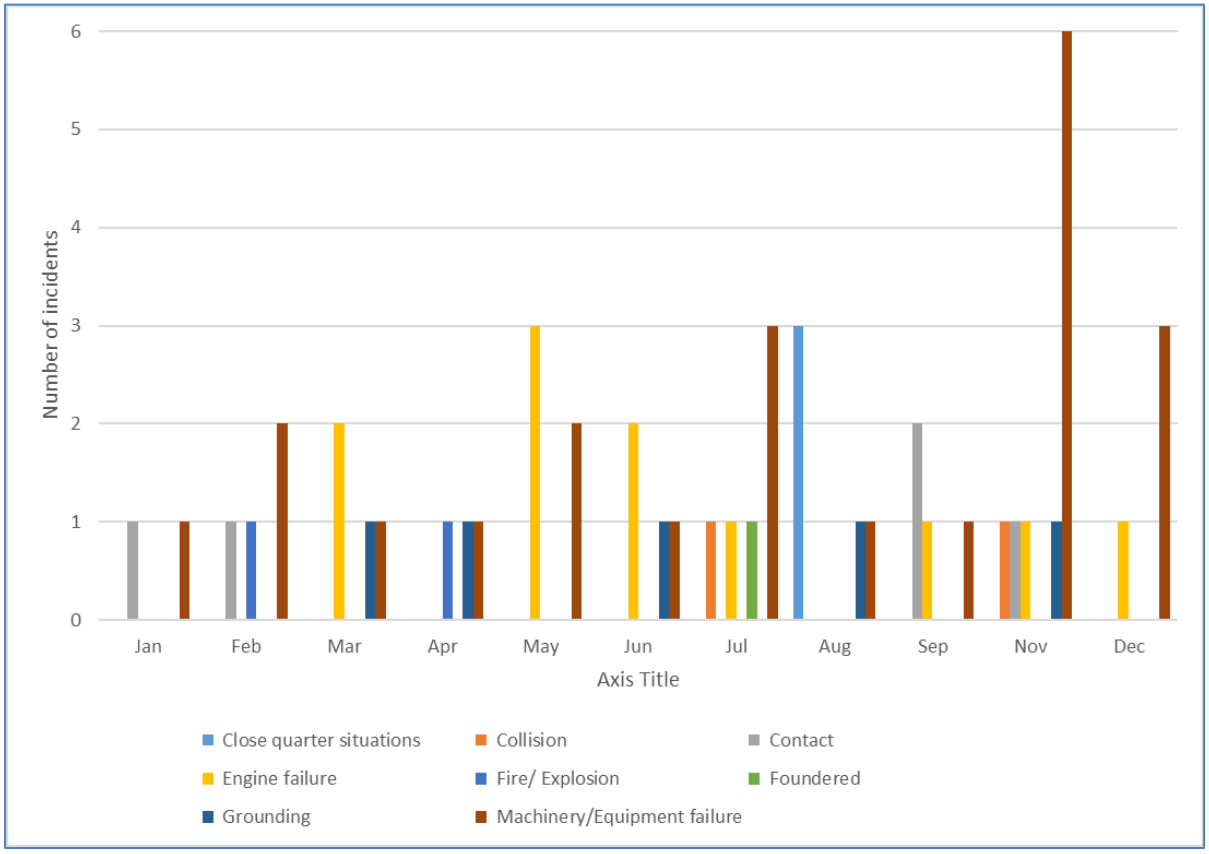


Figure 24: Incidents and Near Misses Reported 2018 (selected categories).

While detailed analysis of incident location was not possible, manual review of the data supplied corresponded with the evidence provided in the MAIB data.

8 FUTURE TRAFFIC PROFILE

8.1 PEMBROKE DOCK COMMERCIAL TRAFFIC

While both Pembroke Port and MHPA are actively looking to increase business and, therefore, vessel traffic within the wider Waterway there are currently no firm commitments to new services, and with the exception of possible growth in marine renewable energy related traffic, it is not expected that traffic profiles will be dissimilar from those analysed in **Section 6** of this report.

8.2 TRAFFIC DURING CONSTRUCTION PHASE

During the construction phase of the PDI project there is likely to be a temporary and minor increase in traffic density within and adjacent to the work area (compared to current traffic levels). This is expected to include:

- Small dredgers and possibly spoil barges (self-propelled or with tugs);
- Survey vessels; and
- Small general work boats / crew boats.

Some of the works may be carried out from the shore at low tide, bringing land-based equipment (long reach excavators for example) close to navigational areas of the dock.

Construction vessel movements anticipated in relation to the slipway works are presented in Table 8-1. There are no construction vessel movements associated with the works at the Timber Pond or Graving Dock.

Table 8-1: Possible Construction Vessel Movements – Slipway.

	Dredger	JUB/ Barge and Crane	Barge Movements
Dredging Operation	1		22
Stone Bedding		1	4
Precast Slabs			5

8.3 FUTURE RENEWABLE ENERGY RELATED TRAFFIC

Upon completion of the construction phase, and provision of the new facilities it is envisaged that the number of vessels servicing the marine renewable energy industry, and in particular the local proposed META test sites, will become greater and increase the current traffic density. Such vessels

may typically comprise small to medium work boats, occasional jack up barges, high speed crew transfer vessels and survey craft.

Increased traffic density will lead to a greater opportunity for navigation incidents, but vessels over 20m LOA will be subject to the existing port traffic management controls already in place in the Waterway.

9 POTENTIAL IMPACTS TO NAVIGATION

Based on consultation with stakeholders and a review of the traffic profile around the project site, the following potential impacts were reviewed as recommended within MGN 543.

ID	Description
1	Impact on Vessel Traffic Routeing
2	Impact on Contact/Allision Risk
3	Effect of the Tides, Tidal Streams and Weather
4	Impact on Under Keel Clearance
5	Impact on Fishing Activity
6	Impact on Recreational Activity
7	Impact on Subsea Cables
8	Impact on Search and Rescue and Emergency Response
9	Impact on Communications, Radar and Positioning Systems
10	Cumulative and In-Combination Effects

9.1 IMPACT ON VESSEL TRAFFIC ROUTEING

The proposed redevelopment and ongoing operations will generate additional movements of vessels which are most likely to be in the currently assessed “tugs and other service vessel” category. These vessels are likely to be able to use either of the two existing routes into the port (east and west of the Dockyard Bank).

The Ferry service is the predominant user of the Port at present, and Irish Ferries provided specific feedback to the consultation exercise. In particular, it was stressed that there is a narrow navigable channel through which the ferry transits, and ideally no other vessel movements should be permitted during the transit to the berth. There was a general concern that any increased traffic may cause delays to the ferry service (see Table 4-3).

Existing commercial traffic – and especially the ferries – use the eastern approach, but potential for conflict is likely to be managed by means of VTS traffic management, and the possibility of using the alternative approach channel.

9.2 IMPACT ON CONTACT/ALLISION RISK

The additional traffic predicted may increase the potential for collision / allision (with existing structures) due to increased traffic density. However, existing control measures including clear channel marking, proactive VTS traffic management and zoning of the Waterway, will remain effective. It is recommended that MHPA require minimum levels of competence and local knowledge for all vessel masters using the docks, even if vessel sizes are small and masters may not require STCW certification.

9.3 THE EFFECTS OF TIDES, TIDAL STREAMS AND WEATHER

The redevelopment is in a sheltered area and is unlikely to have any effect on existing tidal patterns. Operations from the re-configured slipways may be tidally constrained and working within tidal windows may need to be considered in traffic management planning – especially if such windows coincide with other vessel (e.g. ferry) movements.

9.4 IMPACT ON UNDER KEEL CLEARANCE

This project (being redevelopment of dockside facilities) is unlikely to have any ongoing impact on under keel clearance. During the construction phase, any construction related obstructions should be managed by appropriate control measures (temporary AtoNs, Notices to Mariners, proactive traffic management).

9.5 IMPACT ON FISHING ACTIVITY

There is no evidence of any commercial fishing activity within the project area or approaches and, therefore, no impact is anticipated.

9.6 IMPACT ON RECREATIONAL ACTIVITY

It has been established that leisure activities can be intensive in the Waterway, especially during the summer months; however, consultees confirmed that leisure navigation close to the project area and existing Pembroke Port berths is very limited. Negligible impact on recreational vessels is, therefore, expected near the construction site.

During both the construction and operational phases there will be an increase in vessel movements to and from the port, and these vessels will transit the wider Waterway via one of the two approach

channels. See **Sections 9.1 and 9.2** for a discussion on the potential impacts of increased traffic density.

9.7 INTERACTION WITH SUBSEA CABLES

As noted in **Section 5.4.2** no subsea cables are charted close to the project site; however, the historical uses of the site suggest the possibility that disused cables may be encountered during construction. This is unlikely to have any navigational impact other than the possibility of introducing project delays and increasing the overall time during which construction may impact on other navigation.

During the operational phase, the navigational impact will be unchanged from existing conditions, with a possibility remaining of any class of vessel suffering a snagged anchor in the vicinity. This possibility is already mitigated by the area not being currently recommended for anchoring, and the existing chart notes.

9.8 IMPACT ON SEARCH AND RESCUE AND EMERGENCY RESPONSE

The construction phase of the project is likely to have minimal impact on SAR response, though consideration will need to be given during this phase to access to vessels and the shore for lifeboats and helicopters while construction is underway (Provision of safe access / landing sites). This project does not require an Emergency Response and Co-operation Plan (ERCOP) and should be covered by existing Port Emergency Plans. However, consideration should be given to reviewing the Port Emergency Plan in light of the changed use of the port infrastructure during construction and operation. Consideration should also be given to providing a safety boat during construction.

9.9 IMPACT ON COMMUNICATIONS, RADAR AND POSITIONING SYSTEMS

No impacts are anticipated.

9.10 CUMULATIVE AND IN-COMBINATION EFFECTS WITH OTHER ACTIVITIES

The PDI development is closely associated with the META Phase 2 project which consists of three sites for the testing of wave and tidal energy devices within and close to the Waterway, and subject to a separate NRA, and the META Phase 1 project which consists of five additional test sites within the Pembroke Port area. The in-combination effect is, by design, an increase in traffic density as PDI has been designed to accommodate the additional marine traffic which will be required to service the META devices, and potentially additional marine renewable energy developments in the future.

The consequence is an increase in traffic levels above those already existing. This has been considered within the NRA through review of potential incident frequency – more traffic presents an increased opportunity for hazards to be realised. Control measures are discussed in **Section 10.3**.

10 NAVIGATION RISK ASSESSMENT

10.1 INTRODUCTION AND METHODOLOGY

This NRA was commissioned to assess the impact on navigation potentially caused by the development and continued operation of PDI. The NRA is limited to identifying and quantifying any additional or increased navigational risk resulting from the project. It subsequently identifies possible mitigation measures where appropriate and makes recommendations.

The process starts with the identification of all potential hazards. It then assesses the likelihood (frequency) of a hazard causing an incident and considers the possible consequences of that incident. It does so in respect of two scenarios, namely the "most likely" and the "worst credible". The quantified values of frequency and consequence are then combined using a Marico risk algorithm to produce a risk score for each hazard. These are collated into a "Ranked Hazard List" from which the need for possible additional mitigation may be reviewed.

The hazards were scored using the collective experience of the project team and feedback provided by consultees, and drawing on traffic analysis, incident analysis and other available information to support the assessment. For a description of the risk assessment methodology see **Annex A**.

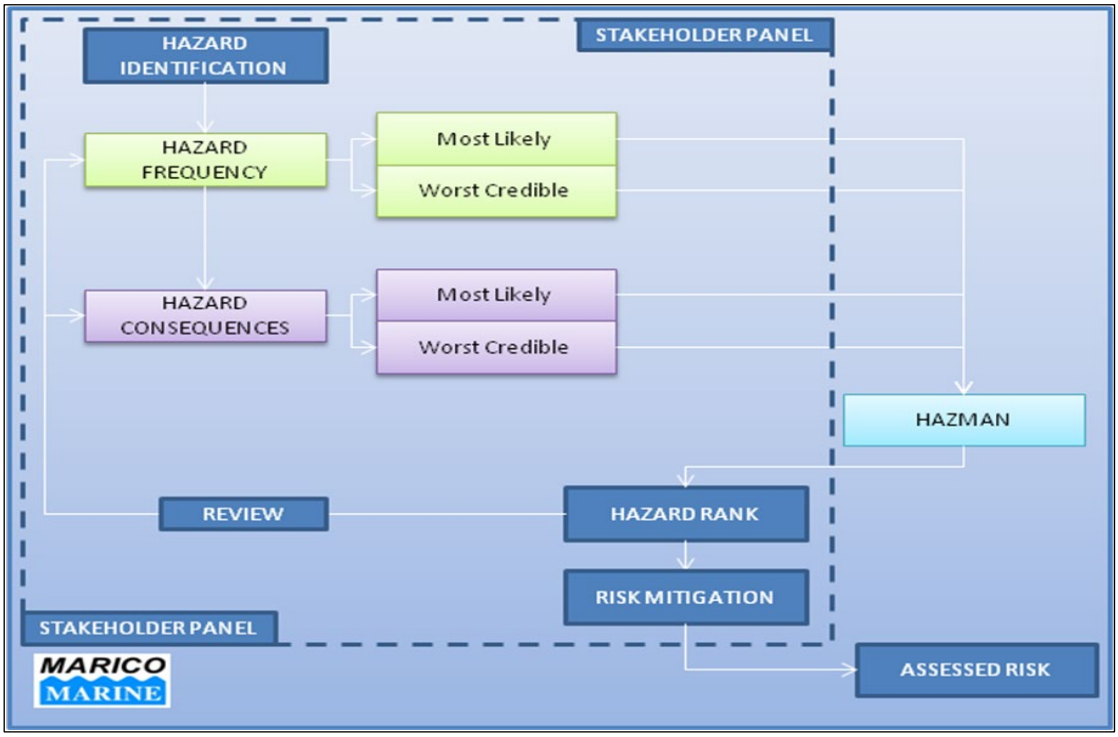


Figure 25: Marico Marine Risk Assessment Methodology.

10.2 HAZARD IDENTIFICATION

The following sources were used in order to identify hazards:

- Existing MHPA Navigation Risk Assessments;
- Historical incident data (See **Section 7**);
- Stakeholder consultation; and
- Assessor professional opinion and experience.

10.2.1 Existing MHPA Navigational Risk Assessments

The Port Authority shared a summary of their existing NRAs which have been undertaken and kept under review in compliance with the requirements of the Port Marine Safety Code (PMSC).

Figure 26 shows the top 10 hazards assessed by MHPA (Higher score equates to greater risk).

Register Rank	Register Hazard Ref	Hazard Title	Category	Inherent Risk	Residual Risk
1	135	Large Vessel contacts berth/vessel after taking avoiding action	Contact Navigation	7.89	6.23
2	49	Contact Berthing LNG Carrier	Contact Berthing	6.1	6.1
3	123	LNG Carrier Fire	Fire\Explosion	6.24	5.97
4	95	Tanker grounding (non-VLCC) East Channel	Grounding	6.77	5.92
5	84	VLCC Grounding at Entrance	Grounding	5.96	5.77
6	78	Cruise ship and large vessel collision	Collision	5.94	5.77
7	64	LNG vessel in collision in port approach	Collision	5.91	5.67
8	98	Ferry grounds at the entrance	Grounding	7.2	5.67
9	35	Sinking of Pilot boat	Sinking/capsize	6.05	5.6
10	143	Large vessel grounds after taking avoiding action	Grounding	6.55	5.6

Figure 26: MHPA Top 10 Navigational Risks.

It can be seen that most of these risks are connected with the very large vessel movements within the lower reaches of the Waterway, but they do identify the following hazard categories:

- Grounding;
- Collision;
- Contact;
- Fire / Explosion; and
- Sinking capsizing.

All of the NRAs undertaken by MHPA (a total of 111 directly related to navigation) have been analysed and ranked by sum of total residual risk (**Figure 27**).

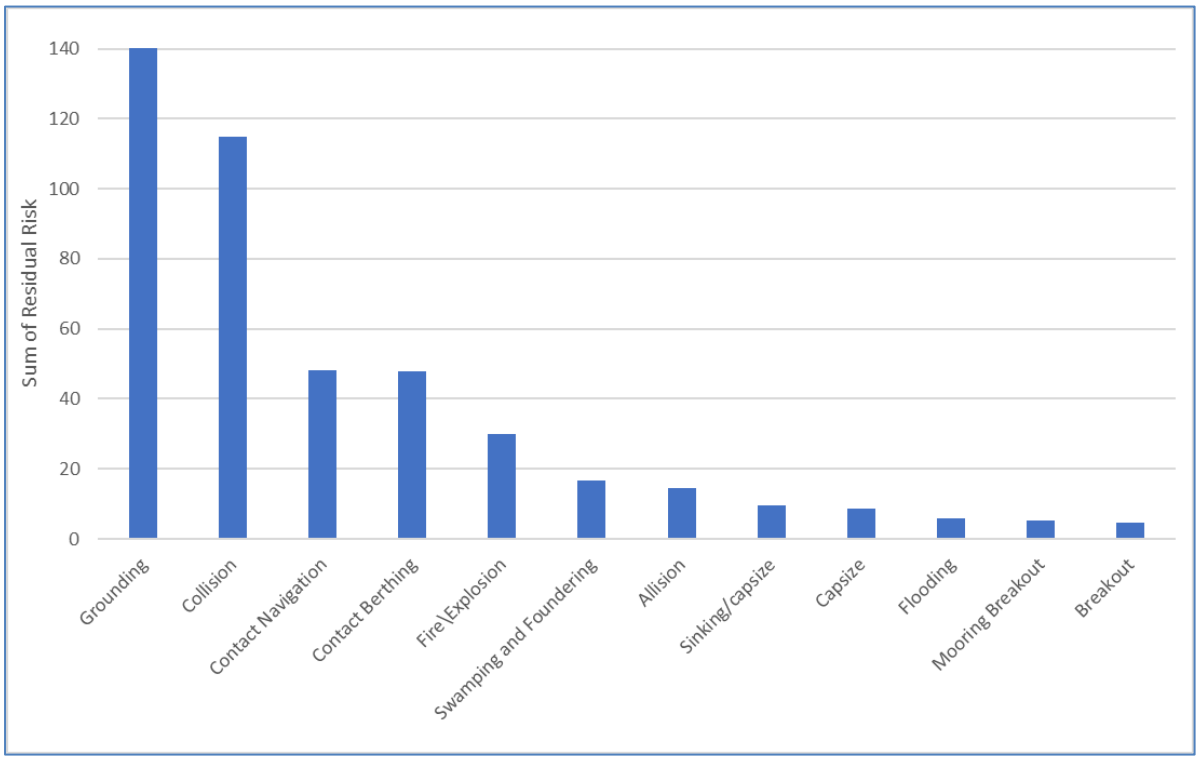


Figure 27: Hazards Categorised by Residual Risk.

The top risks assessed by this method are, therefore, very similar to those identified as the top 10 ranked risks.

10.2.2 Historical Incident data

The incident data described in **Section 7** identifies similar hazard categories with Contact, Grounding and Collison being the top navigational hazards (excluding mechanical failure / loss of control which can be considered a cause).

10.2.3 User Consultation

No other hazard categories were identified for assessment during user consultation (in relation to the PDI development).

10.2.4 Hazard Categories to be used for this NRA

The following hazard types have been identified for assessment:

- **Collision** – two navigating vessels come into contact;
- **Contact/Allision** – a navigating vessel comes into contact with a fixed or stationary object (i.e. port infrastructure);
- **Grounding** – a navigating vessel makes contact with the seabed;
- **Sinking / Capsizing (including Swamping / Foundering)** – a vessel sinks or capsizes during normal operations or as a result of external factors (Includes vessels engaged in the project, or project impacting on other vessels); and
- **Fire / Explosion –** a fire or explosion occurs on a vessel in the assessment area (including fire aboard a vessel engaged in the project).

All of the above hazards will be present at all project stages, including construction and operation.

Vessel categories were defined as follows:

- **Commercial Shipping** – cargo and tankers that carry cargo (including ro-ro, container, bulk or liquid);
- **Passenger Vessels** – passenger ferries and cruise ships;
- **Recreational Vessels** – yachts and pleasure craft; and
- **Tugs and Service Craft** – workboats, tugs, pilot vessels and maintenance vessels. Small craft whose primary purpose is commercial including marine renewable energy service vessels.

The following vessel type is not considered as no movements were identified in the study area:

- **Fishing Vessels** – vessels of all sizes engaged in commercial fishing or trawling.

10.3 RISK CONTROL OPTIONS

As this project is taking place in a well-established port within a larger PMSC compliant SHA area, all of the identified hazards have previously been risk assessed and risk reduced to as low a level as reasonably practicable through the introduction of a range of appropriate risk controls. These controls will continue to apply during the construction and operation phases of the redevelopment and have been considered during this project specific assessment.

Such controls include, but are not limited to:

- Traffic Management Procedures (VTS / berth allocation);
- Lighting and marking of obstructions (AtoNs);
- Charting of sites and obstructions;
- Competence and training of marine personnel;
- Operational procedures;
- Regulations (e.g. Collision Regulations, local byelaws);
- Pilotage;
- Dredging and surveying of the harbour and approaches;
- Waterway management with identified zones for different activities; and
- Dissemination of information via Notices to Mariners, website, year book etc.

10.4 RISK ASSESSMENT

Full hazard logs are contained in **Annex B**.

Table 10-1 shows the top ten risks assessed for the PDI redevelopment. All hazards were assessed to be within the ALARP (yellow) risk region with the existing risk control measures in place. Risk is, therefore, considered to be at an acceptable level both during the construction and operational phases of the project development. It is also noted that the highest risks assessed are associated with existing traffic and conditions, albeit the assessment has considered the higher traffic densities and operational patterns of traffic connected with the construction and operation of the new facility.

Table 10-1: Summary Risk Assessment.

Rank	Hazard Ref.	Affected Areas	Accident Category	Hazard Title	Consequence Descriptions		Risk Overall
					Most Likely (ML)	Worst Credible (WC)	
1	6	Pembroke Port	Collison	Collision: Commercial Vessel - Passenger Vessel / Ferry	Glancing blow, minor damage to both vessels	Multiple injuries on both vessels, major damage to one or both	5.15
2	23	Pembroke Port	Fire / Explosion	Fire / Explosion: Passenger Vessel / Ferry	Most likely is a small passenger vessel with controllable fire	Irish Ferry / Cruise ship with major fire in accommodation / terrorist act	4.7
3	25	Pembroke Port	Fire / Explosion	Fire / Explosion: Commercial Vessel	Fire in engine room / accommodation contained with own resources	Fire on tanker becomes uncontrolled	4.7
4	17	Pembroke Port	Grounding	Grounding: Commercial Vessel	Not Stranded	Grounding leading to loss of structural integrity, and pollution.	4.57
5	4	Pembroke Port	Collison	Collision: Recreational Vessel - Passenger Vessel / Ferry	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	4.52
6	5	Pembroke Port	Collison	Collision: Recreational Vessel - Commercial Vessel	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	4.52
7	9	Pembroke Port	Contact	Contact with structure: Commercial Vessel	Normal "hard berthing" contact	Uncontrolled contact at berth, major damage, multiple injuries	4.48
8	24	Pembroke Port	Fire / Explosion	Fire / Explosion: Recreational Vessel	Fire in engine of yacht, controlled with own resources	Fire engulfs leisure vessel leading to abandonment / explosion of fuel tank	4.35
9	18	Pembroke Port	Grounding	Grounding: Tugs/Service Craft	Not Stranded	Grounding leading to loss of structural integrity, and pollution	4.27
10	26	Pembroke Port	Fire / Explosion	Fire / Explosion: Tugs/Service Craft	Fire in engine room / accommodation contained with own resources	Fire engulfs vessel leading to abandonment / explosion of fuel or cargo	4.25

10.5 POSSIBLE ADDITIONAL RISK CONTROLS

Further additional risk controls identified during the assessment for project-specific implementation are listed below. It is recommended that consideration be given to the introduction of these controls to maintain or reduce the assessed level of risk, especially during the construction phase of the project. It is noted that most of these controls are already in place (see **Section 10.3** above), however, the controls identified below are suggested as additional realistically achievable enhancements.

Table 10-2: Possible Additional Risk Controls.

ID	Name	Description
1.	NTM	Project specific notices during construction phase.
2.	AtoNs	Liaise with THLS to ensure new infrastructure continues to be appropriately marked for navigational safety after construction.
3.	Temporary AtoNs	During construction phase mark works as required and promulgate via NTM.
4.	Safety Vessels	Consider use of safety boats during construction phase (primarily to ensure personal safety of workers, but also to ensure other traffic does not encroach on construction area).
5.	Waterway Management	MHPA to consider introducing specific routes or rules for specific classes of vessels once operational stage is reached to ensure traffic segregation (if traffic density makes this appropriate).
6.	Charting	Update nautical charts and publications and add suitable chart notes after construction is complete.
7.	Enhanced Stakeholder Engagement	Stakeholder engagement is already well established and managed by the MHPA. Consider forming additional stakeholder groups or add new invitees to existing meetings after construction is complete.
8.	Seafarer Competence	It is recommended that MHPA review minimum levels of competence and local knowledge for all commercial vessel masters using the SHA area, even if vessel sizes are small and masters may not require STCW certification.

11 SUMMARY

In summary, all hazards assessed in this NRA have been scored within the ALARP region. The construction and operation of the proposed development either in isolation or in combination with the proposed META project is not expected to increase the risk associated with any of the identified navigation hazards to an unacceptable level, assuming all existing risk controls are maintained.

There is an opportunity to reduce risk still further, and additional risk controls have been proposed. Ensuring all navigators and Waterway users are fully aware of the port redevelopment and revised operations is fundamental to maintaining an acceptable level of risk.

12 REFERENCES

International Maritime Organisation (IMO) (2018) Formal Safety Assessment. IMO Circular MSC-MEPC.2/Circ.12/Rev.2, Available at: http://www.imo.org/en/OurWork/safety/safetytopics/pages/formalsafetyassessment.aspx

MCA (2016) Marine Guidance Note (MGN) 543, Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response, Available at: https://www.gov.uk/government/publications/mgn-543-mf-safety-of-navigation-offshore-renewable-energy-installations-oreis-uk-navigational-practice-safety-and-emergency-response.

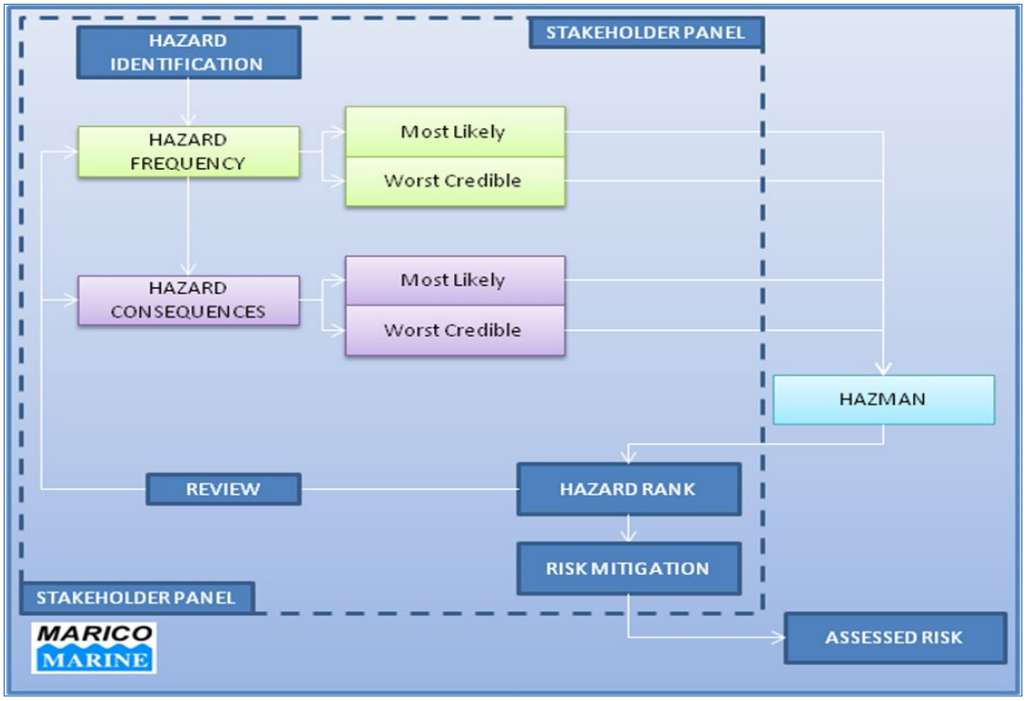
Port Marine Safety Code – DfT November 2016A Guide to Good Practice on Port Marine Operations (Prepared in conjunction with the Port Marine Safety Code" - DfT, February 2018.

Annex A NRA Methodology

Methodology

This NRA was commissioned to assess the impact on navigation potentially caused by the redevelopment and continued operation of PDI. The NRA is limited to identifying and quantifying any additional or increased navigational risk resulting from the project. It subsequently identifies possible mitigation measures where appropriate and makes recommendations.

The process starts with the identification of all potential hazards. It then assesses the likelihood (frequency) of a hazard causing an incident and considers the possible consequences of that incident. It does so in respect of two scenarios, namely the "most likely" and the "worst credible". The quantified values of frequency and consequence are then combined using the Marico HAZMAN software to produce a Risk Score for each hazard. These are collated into a "Ranked Hazard List" from which the need for possible additional mitigation may be reviewed.

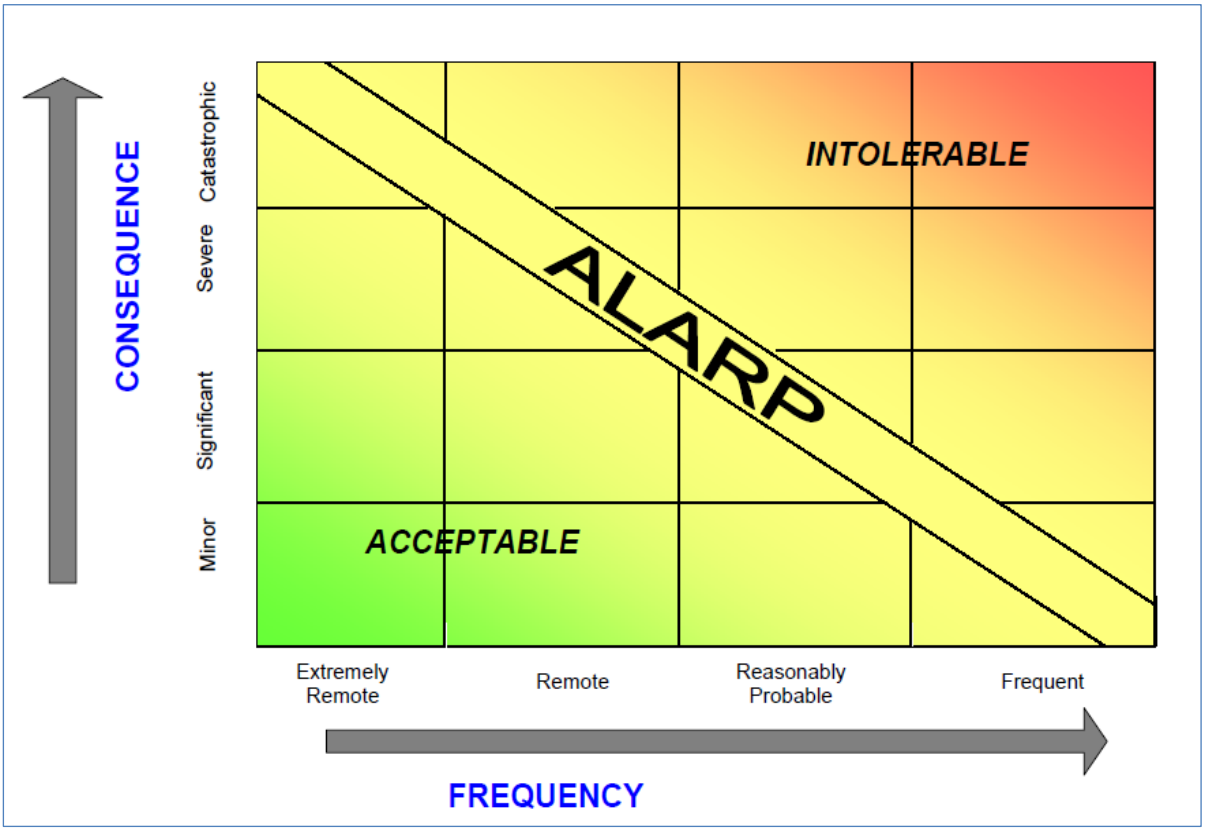


Marico Marine Risk Assessment Methodology.

Criteria for Navigational Risk Assessment

Risk is the product of a combination of consequence of an event and the frequency with which it might be expected to occur. In order to determine navigational risk a Formal Safety Assessment (FSA) approach to risk management is used. International Maritime Organisation (IMO) Guidelines define a hazard as "something with the potential to cause harm, loss or injury", the realisation of which results in an accident. The potential for a hazard to be realised can be combined with an estimated or known

consequence of outcome. This combination is termed "risk". Risk is therefore a measure of the frequency and consequence of a particular hazard.



General risk matrix.

The combination of consequence and frequency of occurrence of a hazard is combined using a risk matrix which enables hazards to be ranked and a risk score assigned. The resulting scale can be divided into three general categories:

- Acceptable;
- As Low as Reasonably Practicable (ALARP); and
- Intolerable.

At the low end of the scale, frequency is extremely remote and consequence minor, and as such the risk can be said to be "acceptable", whilst at the high end of the matrix, where hazards are defined as frequent and the consequence catastrophic, then risk is termed "intolerable". Every effort should be made to mitigate all risks such that they lie in the "acceptable" range. Where this is not possible, they should be reduced to the level where further reduction is not practicable. This region, at the centre of the matrix is described as the ALARP region. It is possible that some risks will lie in the "intolerable" region, but can be mitigated by measures, which reduce their risk score and move them into the ALARP region, where they can be tolerated, albeit efforts should continue to be made when opportunity presents itself to further reduce their risk score.

The FSA methodology used in this NRA, determines where to prioritise risk control options for the navigational aspects of a project site. It is recommended that the outcome of this risk assessment process feeds into the port's Navigation (Marine) Safety Management System, which is used to manage navigational risk.

Hazard Identification

Hazard identification is the first and fundamental step in the risk assessment process. It was undertaken for this project by three Marico Marine specialists using the results of the analysis and feedback from local stakeholders

Risk Matrix Criteria

As indicated earlier, frequency of occurrence and likely consequence were both assessed for the "most likely" and "worst credible" scenario. Frequencies were assessed according to the levels set out below.

Frequency criteria.

Scale	Description	Definition	Operational Interpretation
F5	Frequent	An event occurring in the range once a week to once an operating year.	One or more times in 1 year
F4	Likely	An event occurring in the range once a year to once every 10 operating years.	One or more times in 10 years 1 - 9 years
F3	Possible	An event occurring in the range once every 10 operating years to once in 100 operating years.	One or more times in 100 years 10 – 99 years
F2	Unlikely	An event occurring in the range less than once in 100 operating years.	One or more times in 1,000 years 100 – 999 years
F1	Remote	Considered to occur less than once in 1,000 operating years (e.g. it may have occurred at a similar site, elsewhere in the world).	Less than once in 1,000 years >1,000 years

Using the assessed notional frequency for the "most likely" and "worst credible" scenarios for each hazard, the probable consequences associated with each were assessed in terms of damage to:

- People - Personal injury, fatality etc.;
- Property – Project and third party;
- Environment - Oil pollution etc.; and
- Business - Reputation, financial loss, public relations etc.

The magnitude of each was then assessed using the consequence categories given below. These have been set such that the consequences in respect of property, environment and business have similar monetary outcomes.

Consequence categories and criteria.

Cat.	People	Property	Environment	Business
C1	**Negligible** Possible very minor injury (e.g. bruising)	**Negligible** Costs <£10k	**Negligible** No effect of note. Tier1 may be declared but criteria not necessarily met. Costs <£10k	**Negligible** Costs <£10k
C2	**Minor** (single minor injury)	**Minor** Minor damage Costs £10k – £100k	**Minor** Tier 1 – Tier 2 criteria reached. Small operational (oil) spill with little effect on environmental amenity Costs £10K–£100k	**Minor** Bad local publicity and/or short-term loss of revenue Costs £10k – £100k
C3	**Moderate** Multiple minor or single major injury	**Moderate** Moderate damage Costs £100k - £1M	**Moderate** Tier 2 spill criteria reached but capable of being limited to immediate area within site Costs £100k -£1M	**Moderate** Bad widespread publicity Temporary suspension of operations or prolonged restrictions to project Costs £100k - £1M
C4	**Major** Multiple major injuries or single fatality	**Major** Major damage Costs £1M -£10M	**Major** Tier 3 criteria reached with pollution requiring national support. Chemical spillage or small gas release Costs £1M - £10M	**Major** National publicity, Temporary closure or prolonged restrictions on project operations Costs £1M -£10M
C5	**Catastrophic** Multiple fatalities	**Catastrophic** Catastrophic damage Costs >£10M	**Catastrophic** Tier 3 oil spill criteria reached. International support required. Widespread shoreline contamination. Serious chemical or gas release. Significant threat to environmental amenity. Costs >£10M	**Catastrophic** International media publicity. Project site closes. Operations and revenue seriously disrupted for more than two days. Ensuing loss of revenue. Costs >£10M

Hazard Data Review Process

Frequency and consequence data were assessed for each hazard drawing initially on the knowledge and expertise of the Marico Marine specialists. This was subsequently influenced by the views and experience of stakeholders, as well as historic incident where available. It should be noted that the hazards were scored on the basis of the "status quo" i.e. with all existing mitigation measures taken into consideration. The outcome of this process was then checked for consistency against the assessments made in previous and similar risk assessments.

Having decided in respect of each hazard which frequency and consequence criteria are appropriate for the four consequence categories in both the "most likely" and "worst credible" scenarios, eight risk scores were obtained using the following matrix.

Risk factor matrix used for hazard assessment.

Consequences	Cat 5	5	6	7	8	10
	Cat 4	4	5	6	7	9
	Cat 3	3	3	4	6	8
	Cat 2	1	2	2	3	6
	Cat 1	0	0	0	0	0
	Frequency	**>1,000 years**	**100-1,000 years**	**10-100 years**	**1 to 10 years**	**Yearly**

Where:

Risk Number	*Risk*
0 to 1.9	*Negligible*
2 to 3.9	*Low Risk*
4 to 6.9	*As Low as Reasonably Practical*
7 to 8.9	*Significant Risk*
9 to 10.0	*High Risk*

It should be noted that occasionally, a "most likely" scenario will generate a higher risk score than the equivalent "worst credible" scenario; this is due to the increased frequency often associated with a "most likely" event. For example, in the case of a large number of small contact events, the total damage might be of greater significance than a single heavy contact at a much lesser frequency.

Hazard Ranking

The risk scores obtained from the above process were then analysed further to obtain four indices for each hazard as follows:

- The average risk score of the four categories in the "most likely" set;
- The average risk score of the four categories in the "worst credible" set;
- The maximum risk score of the four categories in the "most likely" set; and
- The maximum risk score of the four categories in the "worst credible" set.

These scores were then combined in Marico Marine's hazard management software "HAZMAN" to produce a single numeric value representing each of the four indices. The hazard list was then sorted

in order of the aggregate of the four indices to produce a “Ranked Hazard List” with the highest risk hazards prioritised at the top.

Mitigation

Additional mitigation measures (over and above those already in place) that could be employed to reduce the likelihood or consequence of the hazards occurring are then identified.

Annex B Pembroke Dock Infrastructure Risk Assessment

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
1	Collison	Collision: Tugs/Service Craft - Recreational Vessel	A tug or service craft collides with a recreational vessel of any type in vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, both vessels continue on voyage	Leisure vessel sinks with loss of life	2	2	1	1	3	4	3	3	3	2	3.1
2	Collison	Collision: Tugs/Service Craft - Commercial Vessel	A tug or service craft collides with a commercial vessel in the vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, minor damage to both vessels	Multiple injuries, smaller craft sinks	2	2	2	2	3	4	4	3	3	2	3.5
3	Collison	Collision: Tugs/Service Craft - Passenger Vessel / Ferry	A tug or service craft collides with a passenger vessel (any type carrying paying passengers) in the vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, minor damage to both vessels	Multiple injuries on a large passenger vessel, loss of life if small passenger vessel	2	2	2	2	3	4	4	3	4	2	3.6

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
4	Collison	Collision: Recreational Vessel - Passenger Vessel / Ferry	Any type of recreational vessel collides with a passenger vessel (any type carrying paying passengers) in the vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	3	2	2	2	3	5	4	3	4	2	4.5
5	Collison	Collision: Recreational Vessel - Commercial Vessel	Any type of recreational vessel collides with a commercial vessel in the vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	3	2	2	2	3	5	4	3	4	2	4.5
6	Collison	Collision: Commercial Vessel - Passenger Vessel / Ferry	A commercial vessel collides with a passenger vessel (any type carrying paying passengers) in the vicinity of the works	Poor seamanship, Failure to comply with regulations, Poor visibility / weather, One vessel suddenly alters course to avoid works or dock structure, Traffic density, Machinery or equipment failure	Glancing blow, minor damage to both vessels	Multiple injuries on both vessels, major damage to one or both	3	3	2	3	4	4	4	3	4	2	5.2
7	Contact / Allision	Contact with structure: Passenger Vessel / Ferry	A passenger vessel makes contact with a fixed structure. (e.g. Jetty structure or temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction (e.g. jetty or temporary works) not charted or promulgated, Machinery or equipment failure.	Normal "hard berthing" contact	Uncontrolled contact at berth, major damage, multiple injuries	1	1	1	1	5	4	4	3	4	2	2.3

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
8	Contact / Allision	Contact with structure: Recreational Vessel	A recreational vessel makes contact with a fixed structure. (e.g. Jetty structure or temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction (e.g. jetty or temporary works) not charted or promulgated, Machinery or equipment failure.	Glancing blow due to misjudgement. Possible injuries on vessel	Serious damage leading to water ingress, and further consequence, e.g. sinking. Multiple injuries	2	1	1	1	3	4	3	3	3	1	2.6
9	Contact / Allision	Contact with structure: Commercial Vessel	A commercial vessel makes contact with a fixed structure. (e.g. Jetty structure or temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction (e.g. jetty or temporary works) not charted or promulgated, Machinery or equipment failure.	Normal "hard berthing" contact	Uncontrolled contact at berth, major damage, multiple injuries	2	2	1	1	5	4	4	3	3	2	4.5
10	Contact / Allision	Contact with structure: Tugs/Service Craft	A tug / service craft makes contact with a fixed structure. (e.g. Jetty structure or temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction (e.g. jetty or temporary works) not charted or promulgated, Machinery or equipment failure, Failure to follow procedures	Normal "hard berthing" contact	Uncontrolled contact at berth, major damage, multiple injuries	2	2	1	1	4	4	3	3	3	2	3.5
11	Contact / Allision	Contact with Floating Object: Passenger Vessel / Ferry	A passenger vessel makes contact with a floating object. (e.g. debris, navigation aid, temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction not charted or promulgated, Machinery or equipment failure.	e.g. striking NavAid	Striking larger object (e.g. large flotsam) possible multiple injuries	1	2	1	2	3	4	3	2	3	1	2.6
12	Contact / Allision	Contact with Floating Object: Recreational Vessel	A recreational vessel makes contact with a floating object. (e.g. debris, navigation aid, temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction not charted or promulgated, Machinery or equipment failure.	e.g. striking NavAid, possible crew injury	Striking larger object (e.g. large flotsam) possible multiple injuries, and significant damage leading to sinking	2	1	1	1	3	4	3	2	3	1	2.5

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
13	Contact / Allision	Contact with Floating Object: Commercial Vessel	A commercial vessel makes contact with a floating object. (e.g. debris, navigation aid, temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction not charted or promulgated, Machinery or equipment failure.	e.g. striking NavAid	Striking larger object (e.g. large flotsam) possible injuries	1	2	1	2	3	3	3	2	3	1	2.3
14	Contact / Allision	Contact with Floating Object: Tugs/Service Craft	A tug / service craft makes contact with a floating object. (e.g. debris, navigation aid, temporary construction works)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Obstruction not charted or promulgated, Machinery or equipment failure, Failure to follow procedures	e.g. striking NavAid	Striking larger object (e.g. large flotsam) possible injuries	1	2	1	2	3	3	3	2	3	2	2.6
15	Grounding	Grounding: Passenger Vessel / Ferry	Any type of passenger ferry grounds (including stranding over more than one tide)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Machinery or equipment failure, Traffic density or position of works causes unplanned course alteration, Inadequate chart / hydrographic information.	Small passenger crafty grounds, no significant impacts, floats off on same tide	Large ferry grounds: multiple injuries during event, major business disruption	3	2	2	3	3	4	4	3	4	1	3.9
16	Grounding	Grounding: Recreational Vessel	Any type of recreational vessel grounds (including stranding over more than one tide)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Machinery or equipment failure, Traffic density or position of works causes unplanned course alteration, Inadequate chart / hydrographic information.	e.g. moving out of channel for other traffic, and "touching bottom" (Not stranded).	Grounding leading to sinking or loss of stability	2	2	2	2	3	4	3	2	3	2	3.3

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
17	Grounding	Grounding: Commercial Vessel	Any type of commercial vessel grounds (including stranding over more than one tide)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Machinery or equipment failure, Traffic density or position of works causes unplanned course alteration, Inadequate chart / hydrographic information.	Not Stranded	Grounding leading to loss of structural integrity, and pollution.	2	3	3	3	3	4	5	5	5	1	4.6
18	Grounding	Grounding: Tugs/Service Craft	Any tug or service craft grounds (including stranding over more than one tide)	Poor seamanship, Poor visibility, AtoN out of position / unlit, Machinery or equipment failure, Traffic density or position of works causes unplanned course alteration, Inadequate chart / hydrographic information.	Not Stranded	Grounding leading to loss of structural integrity, and pollution.	2	3	2	2	3	4	4	4	4	2	4.3
19	Sinking / Capsizing	Sinking / Capsizing: Passenger Vessel / Ferry	Any type of passenger vessel sinks or capsizes in vicinity of works (as a consequence of, or impacting upon works)	Machinery or hull failure, Grounding, Collision, Adverse weather, Poor seamanship, Failure to follow procedure (e.g. Stowing), Terrorist activity.	e.g. small passenger vessel taking on water	Irish Ferry / Cruise vessel sinking requiring mass evacuation	3	3	3	3	2	5	5	4	5	1	4.2
20	Sinking / Capsizing	Sinking / Capsizing: Recreational Vessel	Any type of recreational vessel sinks or capsizes (as a consequence of, or impacting upon works)	Machinery or hull failure, Grounding, Collision, Adverse weather, Poor seamanship, Failure to follow procedure, Intentional for dinghy / canoe capsize training.	"routine" dinghy capsize, attended to by support craft	Larger leisure vessel sinks rapidly, leading to loss of life	1	1	1	1	4	4	3	2	4	3	2.7

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Overall Risk
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
21	Sinking / Capsizing	Sinking / Capsizing: Commercial Vessel	A commercial vessel sinks or capsizes in vicinity of works (as a consequence of, or impacting upon works)	Machinery or hull failure, Grounding, Collision, Adverse weather, Poor seamanship, Failure to follow procedure (e.g. Stowing), Terrorist activity.	Taking on water, safely beached or berthed	Possible loss of life, significant business impact	2	3	3	3	3	4	4	4	4	1	4.1
22	Sinking / Capsizing	Sinking / Capsizing: Tugs/Service Craft	A tug or workboat sinks or capsizes, including while working on construction project	Machinery or hull failure, Grounding, Collision, Adverse weather, Poor seamanship, Failure to follow procedure (e.g. Stowing / cranage), Terrorist activity.	Taking on water, safely beached or berthed	Possible loss of life, significant business impact	2	3	3	3	3	4	3	3	4	1	4.0
23	Fire / Explosion	Fire / Explosion: Passenger Vessel / Ferry	Fire on passenger vessel, with potential to impact construction / operation of project	Machinery or system failure, Poor seamanship (carelessness), Failure to follow procedure	Most likely is a small passenger vessel with controllable fire	Irish Ferry / Cruise ship with major fire in accommodation / terrorist act	3	3	3	3	3	5	5	4	5	1	4.7
24	Fire / Explosion	Fire / Explosion: Recreational Vessel	Fire on recreational vessel, with potential to impact construction / operation of project	Machinery or system failure, Poor seamanship (carelessness), Failure to follow procedure	Fire in engine of yacht, controlled with own resources	Fire engulfs leisure vessel leading to abandonment / explosion of fuel tank	3	2	2	2	3	5	3	3	3	2	4.4
25	Fire / Explosion	Fire / Explosion: Commercial Vessel	Fire on commercial vessel, with potential to impact construction / operation of project	Machinery or system failure, Poor seamanship (carelessness), Failure to follow procedure	Fire in engine room / accommodation contained with own resources	Fire on tanker becomes uncontrolled major impact on construction / operation	3	3	3	3	3	4	5	5	5	1	4.7
26	Fire / Explosion	Fire / Explosion: Tugs/Service Craft	Fire on tug / service vessel, includes vessels engaged in the project, or with potential to impact construction / operation of project	Machinery or system failure, Poor seamanship (carelessness), Failure to follow procedure, on board operations (e.g. welding / burning connected with project)	Fire in engine room / accommodation / on deck contained with own resources P: Moderate - multi	Fire engulfs vessel leading to abandonment / explosion of fuel	3	3	3	3	3	4	4	4	4	1	4.3