Appendix 9:
AMETS Navigation Risk Assessment

SEAI (Sustainable Energy Authority of Ireland)

AMETS (Atlantic Marine Energy Test Site)

Navigation Risk Assessment

AMETS_R_5442

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Contents

Abbreviations

ADCP: Acoustic Doppler Current Profiler
AIS: Automatic Identification System
ALARP: As Low As Reasonably Practicable
AMETS: Atlantic Marine Energy Test Site
ATBA: Area to be Avoided
BERR: Department for Business Enterprise and Regulatory Reform
CER: Commission for Energy Regulation
CIL: Commissioners of Irish Lights
DFT: Department for Transport
DSO: distribution system operator
DTI: Department of Trade and Industry (UK)
EIS: Environmental Impact Statement
ESB: Electricity Supply Board
ESBI: Electricity Supply Board International
FSA: Formal Safety Assessment
GPS: Global Positioning System
H&SMS: Health & Safety Management System
IALA: International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO: International Maritime Organisation
IRCG: Irish Coast Guard
MBS: Maritime Buoyage System
MCA: Maritime and Coastguard Agency
MCIB: Marine Casualty Investigation Board
MF: Medium Frequency
MI: Marine Institute
MRCC: Marine Rescue Centres
MRSC: Marine Rescue Sub Centre
MSI: Maritime Safety Information
MSO: Marine Survey Office
OREI: Offshore Renewable Energy Installation
PPE: Personal Protective Equipment
RIB: Rigid Inflatable Boat
RNLI: Royal National Lifeboat Institute
SAR: Search and Rescue
SEAI: Sustainable Energy Authority of Ireland
SFPA: Sea Fisheries Protection Authority
UKHO: United Kingdom Hydrographic Office
VHF: Very High Frequency
VMS: Vessel Monitoring System
WEC: Wave Energy Converter

1 Executive Summary

1.1 Background

The Sustainable Energy Authority of Ireland (SEAI) is proposing to develop a wave energy test site off the west coast of Ireland. The proposed test site, located off the coast of the mullet peninsula in county Mayo, has been named the Atlantic Marine Energy Test Site (AMETS). AMETS will be used to test full scale pre-commercial Wave Energy Converter (WEC) devices.

As part of the preparation of an Environmental Impact Statement (EIS) for the project, Arup performed a shipping and navigation assessment of the proposed AMETS site. The assessment was carried out in accordance with the UK Department of Trade and Industry (UK DTI) methodology for offshore wind farms (ref [1]) and taking into account guidance MGN 371 (ref [2]) by the UK Maritime and Coastguard Agency.

1.2 Risk Assessment Summary

1.2.1 Understanding of the Existing Environment

Information about the existing environment relating to navigation in the area was gathered to support the Navigation Risk Assessment. This included information on local ports and harbours, standard sailing routes, existing Aids to Navigation, known navigation hazards, industry activity, weather and sea conditions data, bathymetry, fishing grounds etc. No significant impact on navigation was identified on assessment of the existing environment.

The information gathered in relation to existing fishing activities in the area of AMETS, has also been used separately to review the test site's impact on fishing grounds in the area. The possible impacts on fishing grounds have been considered during the selection of the location and size of both test areas which is discussed in greater detail in Chapter 3 of the EIS: Project alternatives.

1.2.2 Consultation Process

A comprehensive list of navigation 'consultees' was developed to support the risk assessment. The list includes all groups, organisations and agencies with a stake and/or interest in the waters off the west coast of Ireland, in particular the region off the Mayo coast. The navigation consultees were divided into the following five categories:

1) Fishing Industry
2) Marine Industry (excl. fishing)
3) Marine Leisure
4) National Authorities/Government Agencies/SAR
5) Port/Harbour

The 'consultees' identified the practices in the region in relation to fishing, navigation, emergency response, potential hazards, etc.. Consultees noted that

navigation routes are likely to be altered slightly as a result of the AMETS development, however it is not envisaged that this will have a significant impact on users of the area. The consultees also highlighted the need for the AMETS development to be appropriately marked using Aids to Navigation and other navigation aids (buoys, AIS, Racon etc.) and included in navigation charts, radio navigation warnings and notices to mariners. Navigation buoys used should be suitable for the sea conditions in the area

Throughout the consultation process there have been extensive meetings with the local fishermen about their fishing activities and their recommendations have been taken into account during the design of the location and size of the test areas also (see Chapter 3 of the EIS: Project alternatives).

1.2.3 Maritime Traffic Analysis

A 28 day maritime traffic survey was carried out in the vicinity of the AMETS. To account for seasonality the survey was carried out over two separate survey periods, winter and summer as recommended in Marine Guidance Note (MGN) 371 (ref [2]) by the UK Maritime and Coastguard Agency. An analysis of the traffic data collected was carried out which included an investigation into existing route positions, traffic levels in and around the test areas and encounter levels.

The level of vessel traffic within 10 NM of AMETS during both periods was low with only 214 vessels recorded over the 28 day period encompassing both survey periods. The maximum number of vessels recorded on any one day over both survey periods was 24.

The highest activity observed during the winter survey was in the inshore area along the coast as vessels travel around Erris head. During the summer survey period activity was higher closer to the outer Test Area A, with smaller craft travelling in the area. A small number of vessel encounters were identified which confirms there is no concern regarding the number of vessels navigating close to one another in the area surrounding AMETS and shows the risk of collision to be minimal.

The site specific analysis of both AMETS test areas shows the level of vessels navigating within the test areas to be low and confirms the unlikely impact of AMETS on navigating traffic. It was noted that activity within the inner Test Area B was particularly rare.

Sailing routes along the coast were highlighted by the data collected. The impact on these sailing routes is not considered to be significant as there are substantial waters to the east and west of the Test Area A for diversion of vessels.

It was determined that fishing vessels are the dominant ship type navigating in the area during both seasons with increasing numbers of commercial and recreational craft during summer season. The survey data does not indicate a significant impact on fishing vessel activity in the area as a result of the AMETS development. Fishing vessels travelling in the area will be required to take alternative routes east and west of the test area. There appears to have been some fishing activity (likely to be potting) carried out within Test Area A during the summer survey, with the presence of three twisted tracks. There may also have been some fishing activity within Test Area B as one fishing vessel was noted in the area during the summer survey, however the vessel path and activity is

unclear. Access to these areas will no longer be available once the development is in place, however due to the small number of tracks observed; the impact is unlikely to be significant.

Based on the data collected, the impact on commercial and recreational vessels navigation will be minimal as very few vessels were recorded passing within both Test Areas.

1.2.4 Risk Assessment

Using all the information gathered from investigations, consultations and the collection of navigation data, a hazard identification exercise has been performed. This process was carried out by project personnel with input from consultees and a panel of experts for the project. A comprehensive hazard log has been developed in line with the DTI methodology and was used to document all the hazards that are likely to exist in relation to navigation during all stages of the development (construction, operation and decommissioning). The hazard log was used to further investigate navigation risks identified and to quantify their likelihood and consequence. Where possible hazards have been identified, this exercise has also been used to identify potential mitigation/control measures to be considered.

Items required to support the risk assessment such as, understating of future case scenarios, construction and decommissioning issues, navigation marking for the development, Search and Rescue (SAR) resources etc. were investigated further to provide a better understanding of the issues and potential constraints to risk control measures available.

The majority of risks identified were deemed acceptable once the necessary control measures were put in place.

There were a number of risks which were identified as tolerable but these will need to be monitored once construction commences and the site is in operation. This included:

i. The risk of a vessel under control making contact with WEC or buoy

ii. The risk of a vessel not under command or drifting making contact with WEC or buoy

iii. The risk of accidents caused by transfer to/from servicing vessel (or helicopter) to a WEC or another service vessel requiring SAR and /or emergency response.

iv. The risk of a person in the water requiring rescue.

v. The presence of AMETS increasing the risk of an accident requiring SAR and also the potential of AMETS hindering SAR operations.

vi. The presence of AMETS increasing the need for emergency response and also the potential of AMETS hindering the ability to provide emergency response.

To limit the impact of risk some important general risk prevention, mitigation and emergency control measures were identified during the risk assessment process. An example of the more general risk control measures included:

i. Adequate marking of the test site: Navigation buoys and lights installed in the area surrounding the site to increase navigation safety

ii. Promulgation of information and warning through radio navigation warnings, notices to mariners and other appropriate media to heighten mariner awareness of site,

iii. Marking of the site on navigation charts in order to inform vessels of the site and give them opportunity to plan alternative route,

iv. SAR response planning to outline procedures in case of emergency, etc.

Also control measures specific to each risk were identified, for instance a control measure cited to prevent a subsea obstacle snagging on fishing equipment includes defining and agreeing with fishermen a procedure for retrieving fishing gear if the gear ends up within the site which may help prevent interference with subsea equipment within site.

1.3 Risk Assessment Recommendations

The following recommendations have been established based on the findings of the AMETS Navigation Risk Assessment:

1. The site will need to be adequately marked (appropriately sized buoys with AIS, equipped with radar reflection panels etc.), noted on navigation charts and included in all radio navigation warnings and notices to mariners. The scheme design for marking of the test site areas will need to be finalised on consultation with national authorities and in line with guidance documents.
2. The test areas should be sized to provide an adequate clearance around each device, accounting for the mooring arrangements of the devices etc. The outline of the Test Areas, as marked on the navigation charts, shall form the boundary of a Safety Zone equivalent to that used to mark restricted areas around windfarms. Vessels shall not be allowed to sail within the Safety Zone.
3. Control measures for frequent users of the area around the test sites should be defined and managed by the test site management organisation. This may include measures such as defining and agreeing with fishermen a procedure for retrieving fishing gear that enters the site
4. Notices are required to be issued in advance of works on the AMETS development such as: construction, decommissioning and the installation of any device;
5. The construction and decomissioning work should be planned and managed to ensure the safety of those involved and other maritime users in this area. This should include the selection of contractors and the working vessels to ensure they are competent and capable of undertaking the works required, and also following offshore industry guidance and best practices.
6. Consideration should be given to providing a guard vessel during the construction/installation and decommissioning phases of the project;
7. Electricity cables will require to be buried or alternatively be protected sufficiently with rock armour in order to minimise the risk of dragged anchor damage.

8. A separate device-specific risk assessment which outlines the hazards relevant to the WEC will need to be prepared before WECs are installed in the AMETS. The device-specific risk assessments should be considered by the test site management organisation and read in conjunction with the findings of this assessment.
9. A reliable inspection, maintenance and casualty response regime will need to be implemented to ensure that the required availability targets specified by IALA standards are met (See Chapter 3 of IALA Navguide – Aids to Navigation Manual ref [8]
10. It is important that both the RNLI and other emergency services understand the layout and workings of the site and are involved in emergency exercises for the site. SAR should also be covered by each device specific risk assessment.

2 Introduction

The Sustainable Energy Authority of Ireland (SEAI) is proposing to develop a wave energy test site off the west coast of Ireland. The test site, located off the coast of the mullet peninsula in county Mayo, has been named the Atlantic Marine Energy Test Site (AMETS). AMETS will be used to test full scale pre-commercial Wave Energy Converter (WEC) devices.

As part of the preparation of an Environmental Impact Statement (EIS) for the project, Arup has carried out a shipping and navigation assessment of the proposed AMETS site. This assessment informs the EIS for the proposed test site.

An assessment of the potential impact of the proposed development on the routeing and safe navigation of vessels in the vicinity of the test site is presented in this report.

The assessment is primarily based on:

- investigation of the existing environment
- consultations with stakeholders, users of the area and relevant national authorities;
- a semi-quantitative analysis of the traffic data in the area, based on 28 days of vessel traffic survey data collected in the area in 2010/2011
- AIS data for the months of January and July 2010 sourced from the Irish Coastguard

Using all the information gathered from investigations, consultations and the collection of navigation data, a risk assessment using quantitative techniques has been performed. This risk assessment process was carried out by project personnel with input from consultees and a panel of experts for the project. A comprehensive hazard log has been developed and was used to document the hazards that are likely to exist in relation to navigation during all stages of the development (construction, operation and decommissioning). The navigation risks outlined in the log were assessed to quantify their likelihood and consequence and to identify potential mitigation/control measures. Items required to support any mitigation or control measures such as, navigation marking, Search and Rescue (SAR) resources were investigated further to provide understanding of the issues and potential constraints.

WEC devices which will be tested at the site are as yet unspecified; thus each device will require a device-specific risk assessment to be undertaken before installation. Device-specific assessments will need to be submitted to the relevant stakeholders prior to consent (with respect to navigation issues) being given (by AMETS Management Organisation) for a specific device to be installed in the AMETS.

3 Regulations and Guidelines

This study has been carried out in accordance with the UK Department of Trade and Industry (DTI) methodology for offshore wind farms (ref [1]) and taking into account guidance MGN 371 (ref [2]) by the UK Maritime and Coastguard Agency (MCA).

Reference is made to these UK regulations for the following reasons:

- there is currently no Irish guidance or regulations for this type of study in relation to ocean energy developments (particularly wave energy sites);
- they are considered state-of-the-art in the sector;
- advice has been given from statutory bodies to use this methodology (e.g. CIL)

3.1 DTI Methodology

The DTI have produced this guidance document, with the co-operation of the DFT (UK Department for Transport), as a Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind farms [taken as applicable in this case to ocean energy developments].

Its purpose is to be used as a template by developers in preparing their navigation risk assessments and for Government Departments to help in the subsequent assessment of these.

The Methodology is centred on risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows that sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions.

The key features of the Methodology are that developers are to:

1. Produce a submission that is proportionate to the scale of the development and the magnitude of the risks.

2. Produce a submission based on assessing risk by Formal Safety Assessment (FSA) using numerical modelling and / or other techniques and tools of assessment acceptable to government and capable of producing results that are also acceptable to government.

3. Estimate the “Base Case” level of risk based on existing densities and types of traffic and the existing marine environment.

4. Predict the “Future Case” level of risk based on the predicted growth in future densities and types of traffic and reasonably foreseeable future changes in the marine environment.

5. Produce a “Hazard Log” listing the hazards caused or changed by the introduction of the development, the risk associated with the hazard, the controls put in place and the tolerability of the residual risk.

6. Define the “risk controls” that will be put in place and create a Risk Control Log.

7. Predict the "Base Case" level of risk based on existing densities and types of traffic, the existing marine environment and with the wind farm in place.
8. Predict the "Future Case" based on future traffic densities and types, the future marine environment and with the development in place.
9. Process this information into a submission including a claim that the risks associated with the development are "Broadly Acceptable" or "Tolerable" on the basis of As Low As Reasonably Practicable" (ALARP) declarations.

and that Government will base their decision on assessing:

1. That the tools and techniques used in the assessments are acceptable.
2. That the claim in the submission shows that the development will meet the sought after level of marine navigational safety.
3. That there is sufficient information with the submission to have confidence in the claim.
4. That there is sufficient information with the submission to have confidence that appropriate risk controls are, or will be, in place.

3.2 MCA Marine Guidance Note 371

MCA (Maritime and Coastguard Agency) Marine Guidance Note 371 (ref [2]) highlights issues that need to be taken into consideration when assessing the impact on navigational safety from offshore renewable energy developments proposed for United Kingdom internal waters, territorial sea or in a Renewable Energy Zone beyond the territorial sea.

The recommendations in this guidance note are intended to be used, primarily, by offshore renewable energy installation developers, seeking consent to undertake marine works.

- Specific annexes to the guidance address particular issues as follows:
- Annex 1: Site position, structures and safety zones
- Annex 2: Developments, navigation, collision avoidance and communications
- Annex 3: MCA's wind farm shipping template for assessing wind farm boundary distances from shipping routes
- Annex 4: Safety and mitigation measures recommended for OREI (Offshore Renewable Energy Installation) during construction, operation and decommissioning
- Annex 5: SAR (Search and Rescue) matters.

These recommendations should be read in conjunction with the "Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms" published by the Department for Business Enterprise and Regulatory Reform.

4 Description of the Project

4.1 Background

Ocean Energy, as a source of renewable energy, has been the subject of ongoing research and development over the past few decades. In recent years prototype WECs have been proposed and developed by a number of ocean energy companies internationally and also in Ireland. Government renewable energy programmes make projections for inclusion of various levels electricity generation from wave power in future years.

Following completion of a consultation process that had begun in 2002, the Marine Institute and Sustainable Energy Authority of Ireland (SEAI) submitted a jointly developed Ocean Energy Strategy for Ireland to the then Department of Communications, Marine and Natural Resources.

The development of a grid-connected national test site, to which full scale pre-commercial WECs could be coupled during their final stages of pre-commercial development, is a key part of the Ocean Energy Strategy for Ireland.

Resulting from this, an offshore wave energy test site (named as AMETS) is proposed to be developed which would facilitate testing and validation of various wave energy converters. The test site will underpin the Government's stated target of achieving 500MW of marine renewables by 2020. It is expected that the experience gained from deployment at the test site will assist commercial scale wave energy production in the future at suitable locations around the Irish Coast.

4.2 Site Selection

A site selection process was completed by ESBI and the MI in 2008 (ref [4]). The exercise considered a number of potential locations along the west coast of Ireland.

Seven primary sites were assessed as indicated in Figure 1 and a scoring matrix was used in the evaluation process to rank the candidate sites. Seabed quality emerged as a key determinant during the project as the presence of an irregular rocky bed across the transition from beach to operating depth was an inhibiting factor at some otherwise attractive locations.

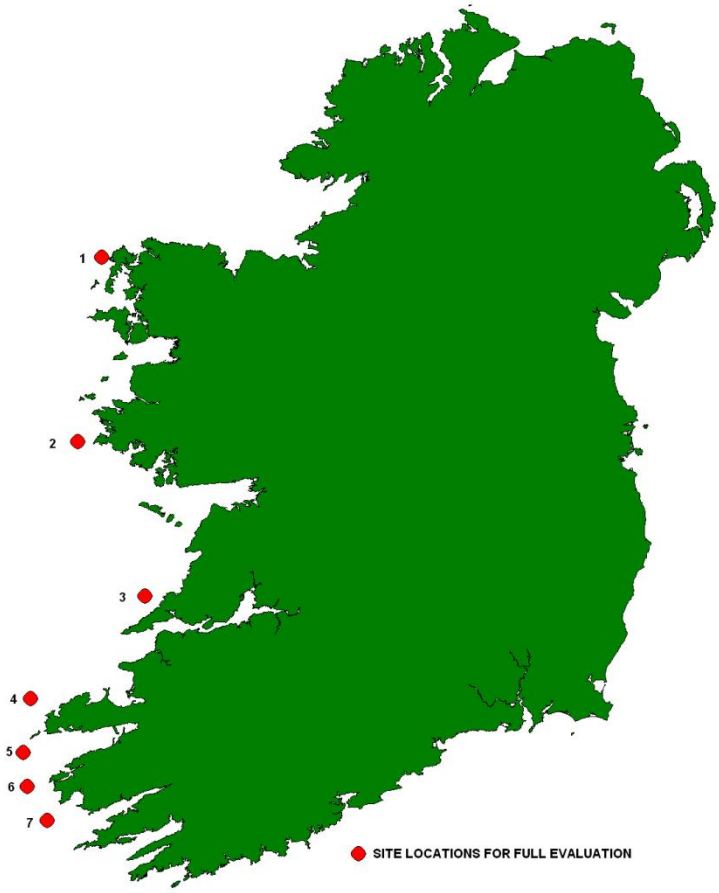

Figure 1 Site candidate locations

The current location, of Annagh Head near Belmullet, Co. Mayo, was considered to be the most suitable for development of a wave energy test site that would satisfy the following criteria;

- Capacity for pre-commercial full scale converter testing (CER permitted 5MW export*)
- Full Atlantic exposure conditions with excellent wave energy resource
- Water depths 50-100m
- Logistic support facilities and shelter within reasonable distance
- Network connection at medium voltage level
- A convenient local site for Irish based wave power developers and researchers, North and South (but not excluding non-Irish based developers).
- Environmental considerations

*The permitted export quantity later increased to 10MW

The location of the proposed wave energy test site is shown in Figure 2 .

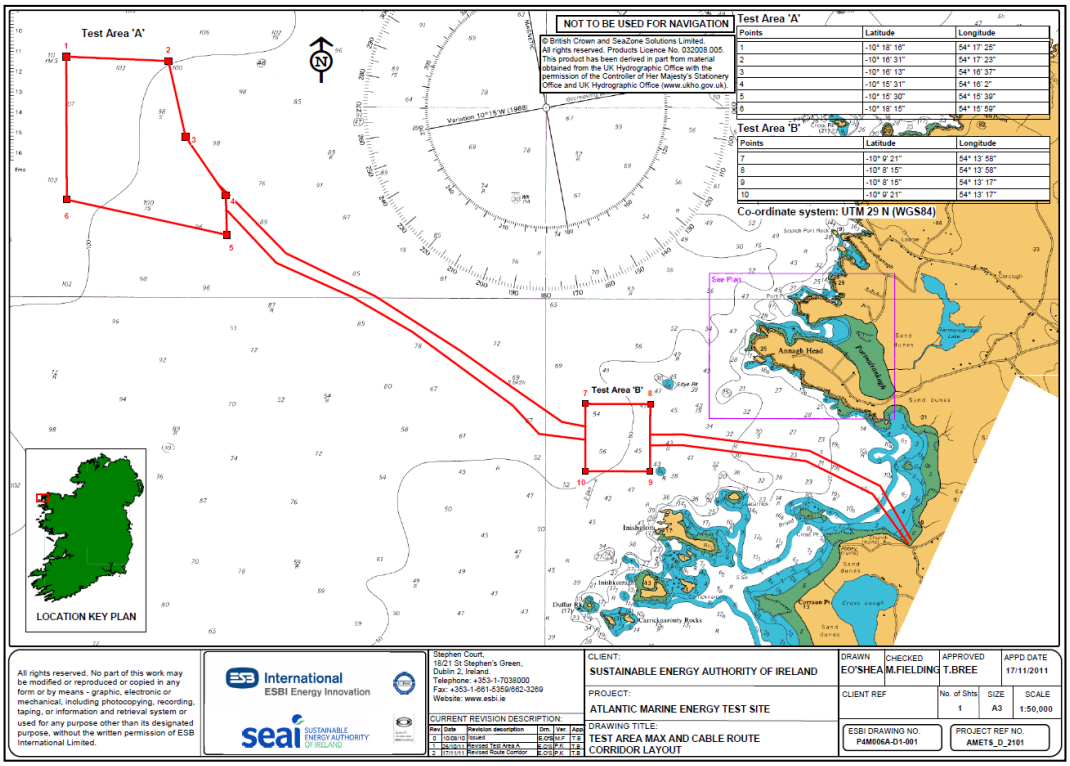

Figure 2 AMETS layout

4.3 Proposed Development Outline Description

Devices proposed for testing at the Belmullet site will consist of offshore WECs which are anchored in deeper water (50m and 100m depth contours).

Offshore deeper water Test Area facilities will be located in two pre-designated Test Areas of varying water depth (100m and 50m). Connection to the distribution electricity network will be via submarine electricity cables from the Test Areas to a land based substation where connection to the grid will occur. The cables will be buried to a minimum depth of 1 metre below the sea bed where sediment depth allows and where burial is not possible cables will be protected using rock armouring or matressing (approx. 4km over bedrock). Rock armouring will be to a height of 1m and a width tapering to 3m at the base.

The proposed test site layout is as detailed below:

- Offshore Test Areas at depths:
    - Test Area A - 100m water depth location
    - Test Area B - 50m water depth location
- Four 10kV submarine electricity cables to transmit power from the Test Areas to land (two from the 50m depth contour and two from the 100m depth contour)
- Onshore substation to interface with the distribution electricity network
- Dedicated feeder overhead power line (wooden pole) from a dedicated substation to Belmullet 38/20/10kV substation (Construction responsibility of the Distribution System Operator (DSO) ESB Networks)

5 Existing Environment

5.1 Introduction

This section presents general information on the existing environment in the area with respect to shipping and navigation.

5.2 Local Ports and Harbours

There are no merchant shipping ports near to the proposed AMETS deployment area. The closest commercial ports include Galway to the south east and Sligo to the north east shown in

Figure 3. There is a fisheries harbour at Rossaveal, west of Galway and another large, deep-water fisheries harbour at Killybegs, north of Sligo also shown in

Figure 3. Killybegs is also used by non-fishing vessels working from the port. This includes off shore supply vessels and an increasing number of passenger liners.

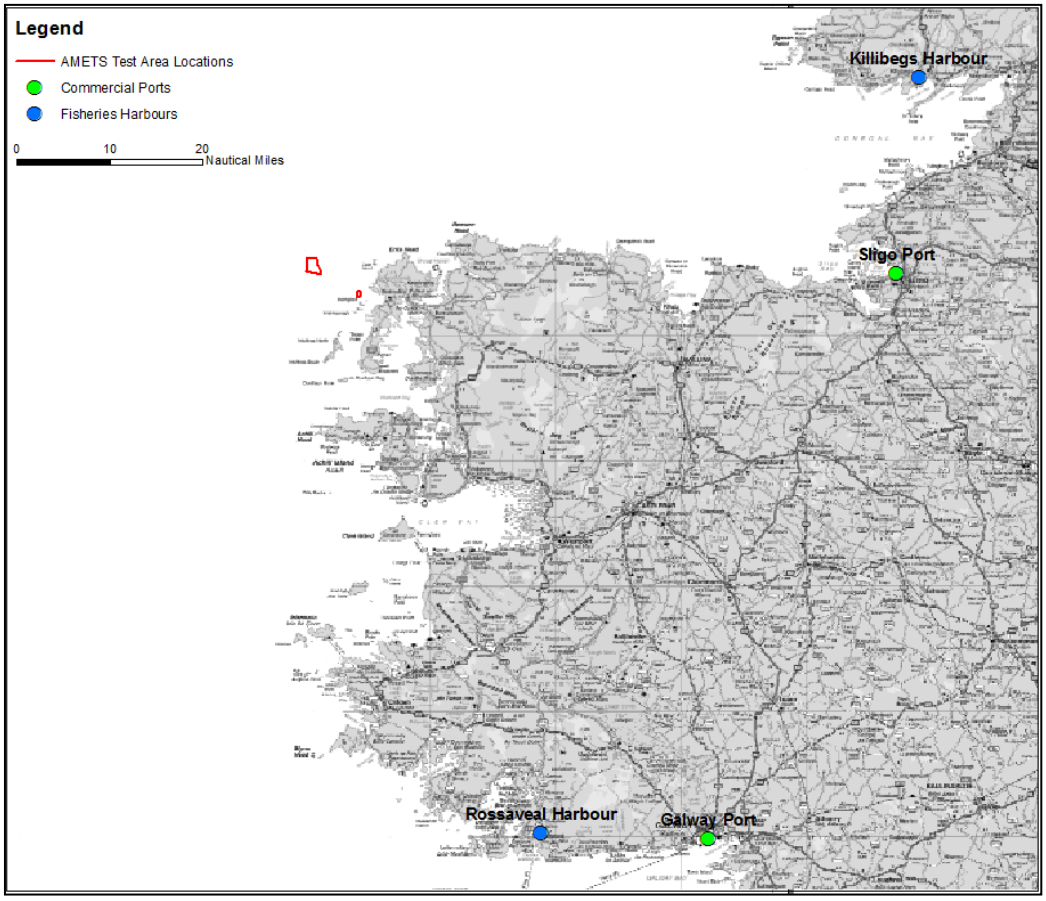

Figure 3 Commercial Ports and large fisheries harbours in the vicinity of the AMETS location

There are also a large number of smaller harbours, piers and slipways dotted along the coast in the area. A number of these are used by smaller fishing vessels, leasure craft and small ferries serving islands. The approximate locations of these berthing facilities are plotted in Figure 4 below.

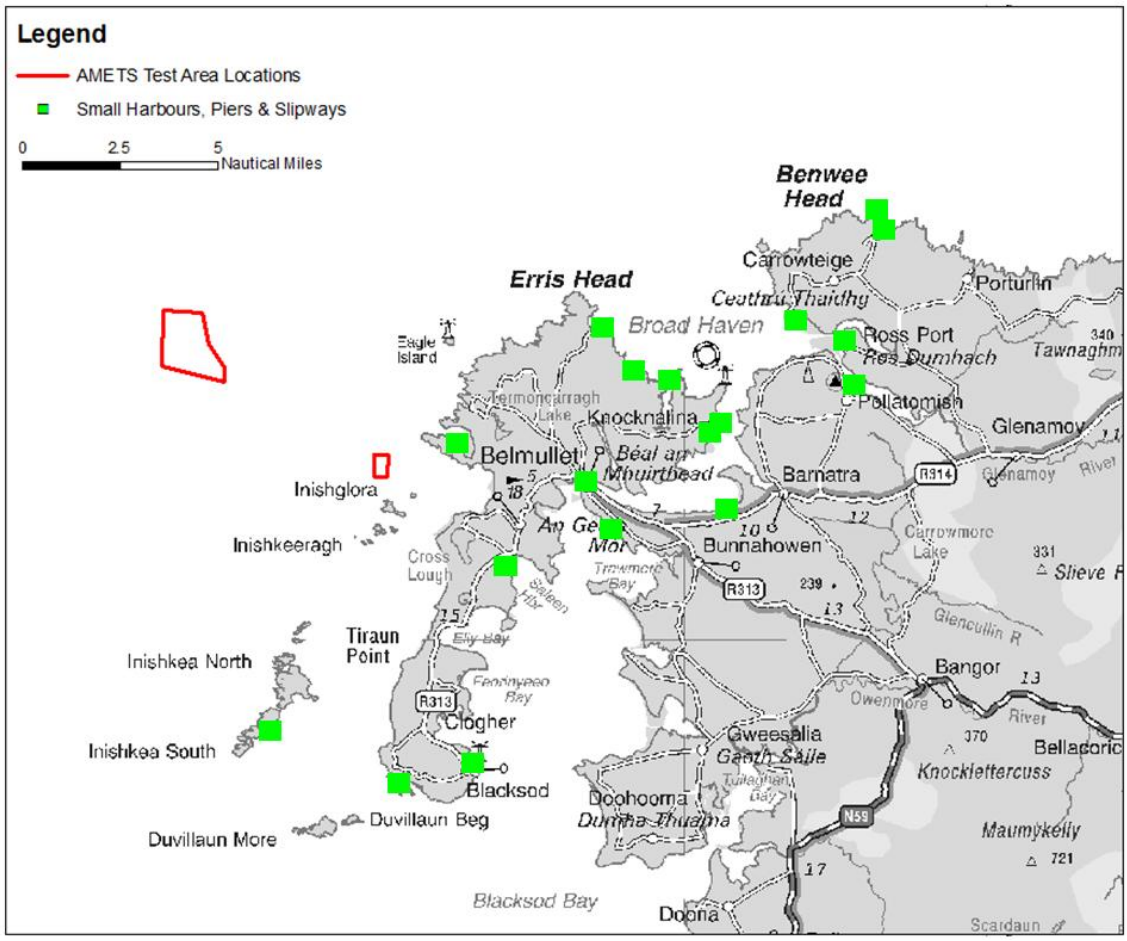

Figure 4 Smaller harbours, piers and slipways in the vicinity of the AMETS location

5.3 Routing Measures

There are no vessel routing measures in place in the locality of the AMETS.

5.4 Aids to Navigational and other Navigation Aids

There are a number of navigation lights in the vicinity of the AMETS as shown in Figure 5. The closest light to the Test Areas A & B is on Eagle Island to the north east.

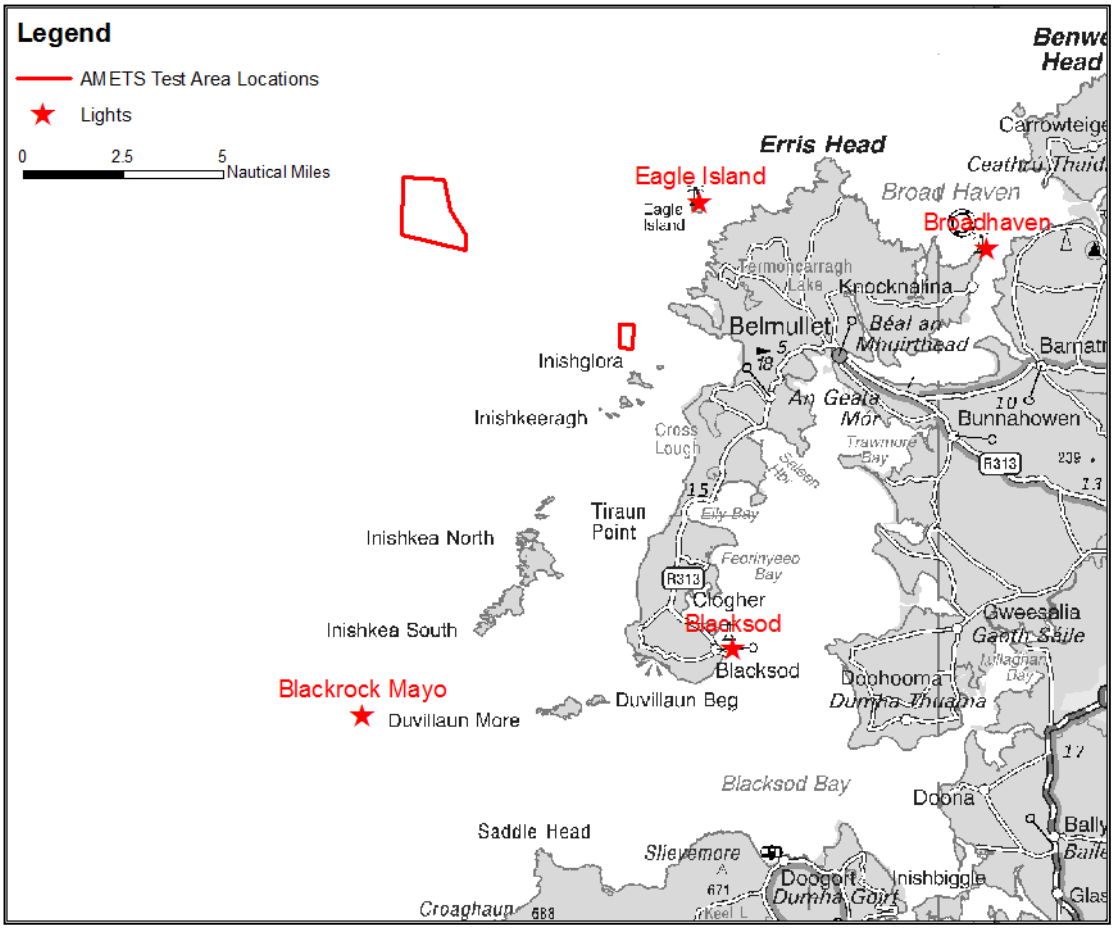

Figure 5 Aids to Navigation in the vicinity of the AMETS location

5.5 Wrecks

No wrecks were identified during the sea bed survey carried out for the site evaluation and selection report. Admiralty maps for the area close to the AMETS location also have no record of the presence of a wreck.

5.6 Oil and Gas Infrastructure

There is a large natural gas field currently under development 83km off the Mayo coast line. The offshore pipeline will run from the Corrib gas field to a landing point near Ballinaboy, Co Mayo via Broadhaven bay. The Corrib gas field is approximately 70km from the AMETS's most western test area. The pipe route for the gas project along with the AMETS test area locations is shown in Figure 6 and Figure 7 below. Once construction is complete, the pipeline will be fully buried. Whilst the gas field is a considerable distance away, the proposed pipeline

linking the gas field to the coast will be approximately 2.9 NM to the north of Test Area A.

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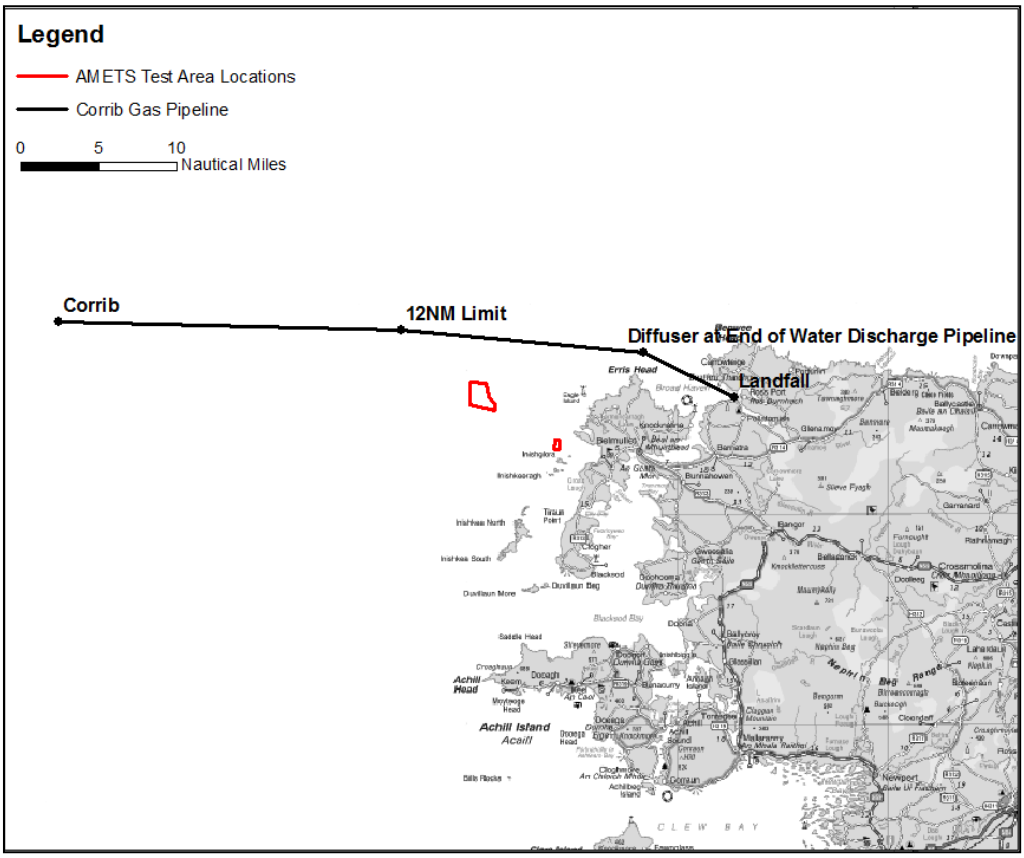

Figure 6 Proposed offshore pipeline route to Corrib gas field.

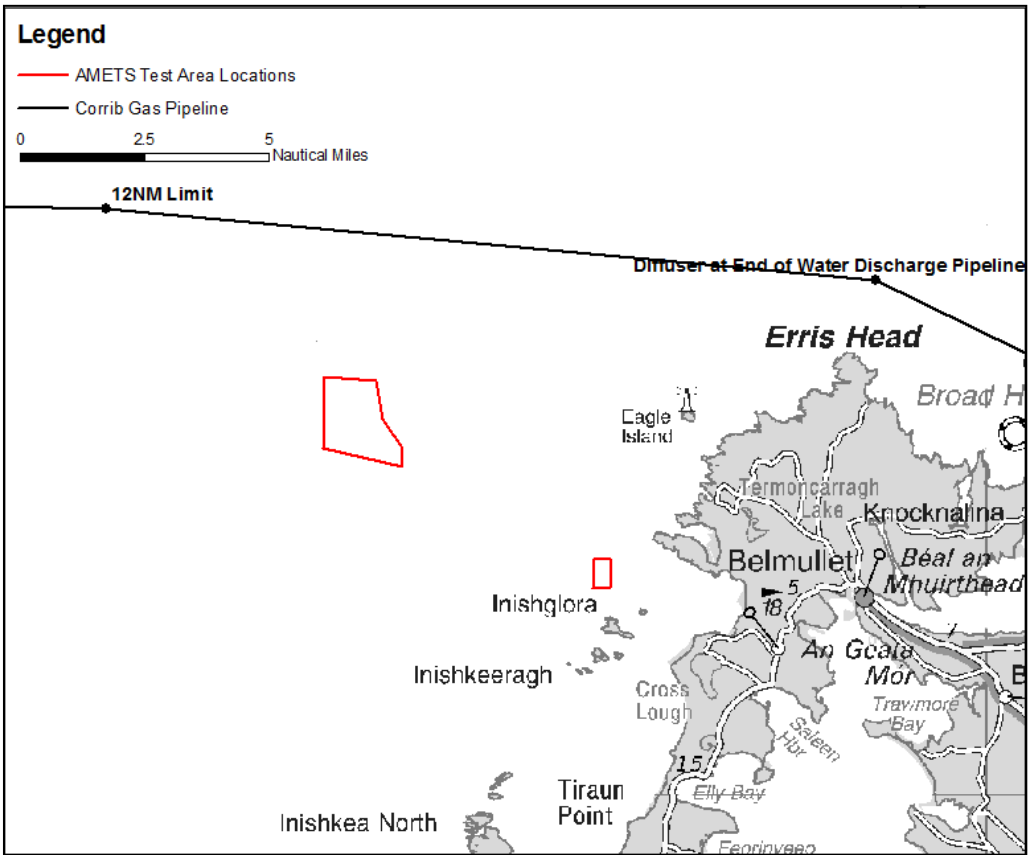

Figure 7 Proposed offshore pipeline route in close proximity to the AMETS.

5.7 Dredging Activity

There is no dredging activity in the surrounding area close to the location of AMETS.

5.8 Exercise Areas

There are no military exercise areas in the vicinity of the AMETS as confirmed by the Department of Defence.

5.9 Metocean Data

This section provides information on the metocean data available in the area of the AMETS.

5.9.1 General Overview

According to the Admiralty Sailing Directions – Irish Coast Pilot, Irish coastal waters enjoy 'a mild maritime climate although it is also a boisterous one with strong winds and high seas. Higher seas are experienced off the west coast of Ireland than in any other coastal region of the British Isles. Gales can occur in any month but are frequent in winter months especially in the West and along the north coasts. Winds reach storm to hurricane strength on some occasions'.

'Rainfall is also plentiful and well distributed throughout the year.'

'Cloudy conditions predominate in all seasons. Coasts are obscured at times by low cloud and driving rain.'

'Fog at sea is infrequent from November to May; it is most prevalent in June. Land fog, commonly the result of radiation cooling on calm nights, is most frequent in autumn and winter in the hours around dawn and can sometimes extend to inshore waters.'

'Good visibility is encountered more frequently off the south coast of Ireland than off the north coast.'

A number of sources were used to obtain data and information in order to describe the metocean conditions in the area of AMETS. There is a Met Éireann weather station at Belmullet and two Marine Institute weather buoys (M1 and M4) off the west coast of Ireland (Figure 8), which have been used to provide a historical overview of the weather in the vicinity of the test site. The Marine Institute have also located a wave rider and wave scan buoy on site at AMETS (Figure 8), which were used to assess wind and wave height in the area. Wave Climatology research carried out by Numerics Warehouse Ltd. in the area for SEAI also proved useful when assessing the wave conditions. This overview is outlined below.

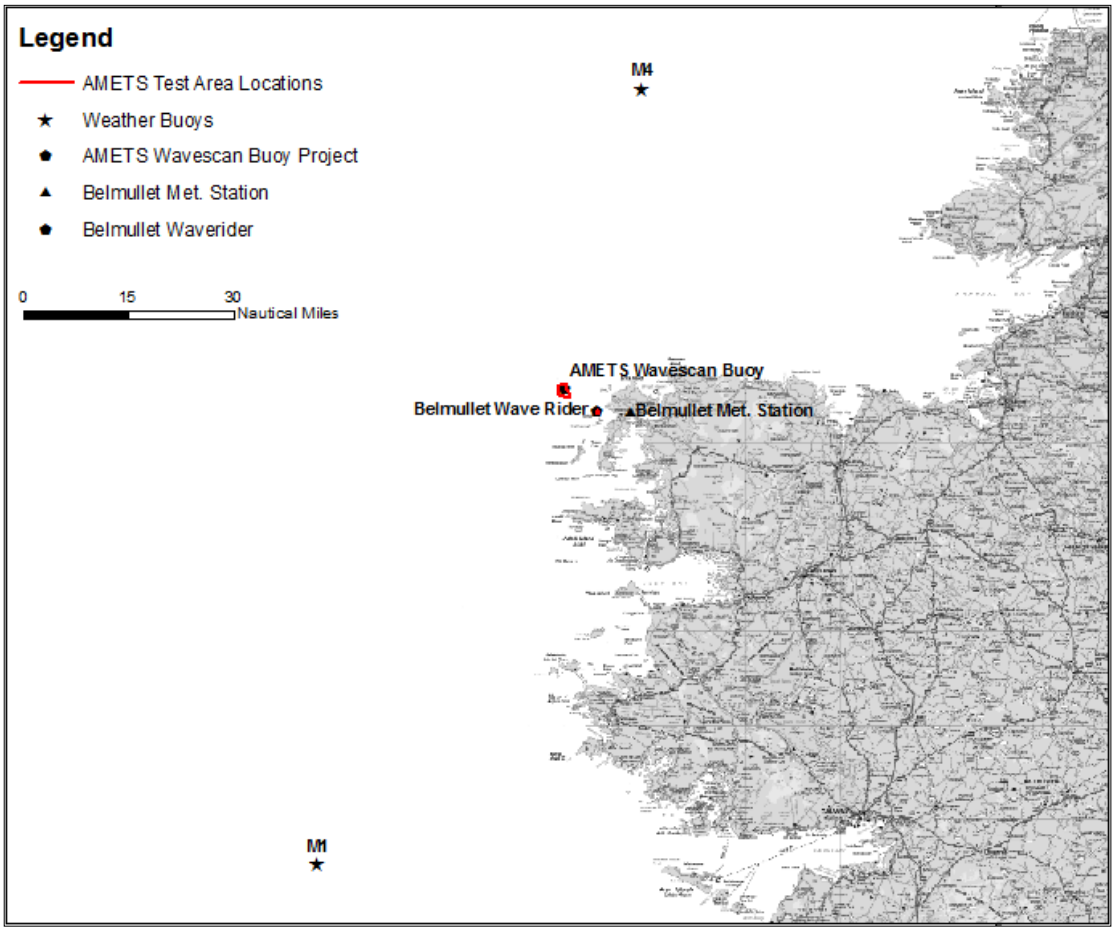

Figure 8 Meteorological stations and weather buoys in the vicinity of AMETS

5.9.2 Wind

5.9.2.1 Weather Buoys (M1, M4)

Wind roses, showing the percentage of wind of a certain wind speed blowing in a certain direction, drawn from data recorded by Marine Institute weather buoys M1 and M4 are shown in Figure 9 and Figure 10.The data from buoy M1 is from the period 2001 to 2007 while the data from buoy M4 is from 2001-2010. Both wind roses show the predominant wind direction is west-south-west (W-SW).

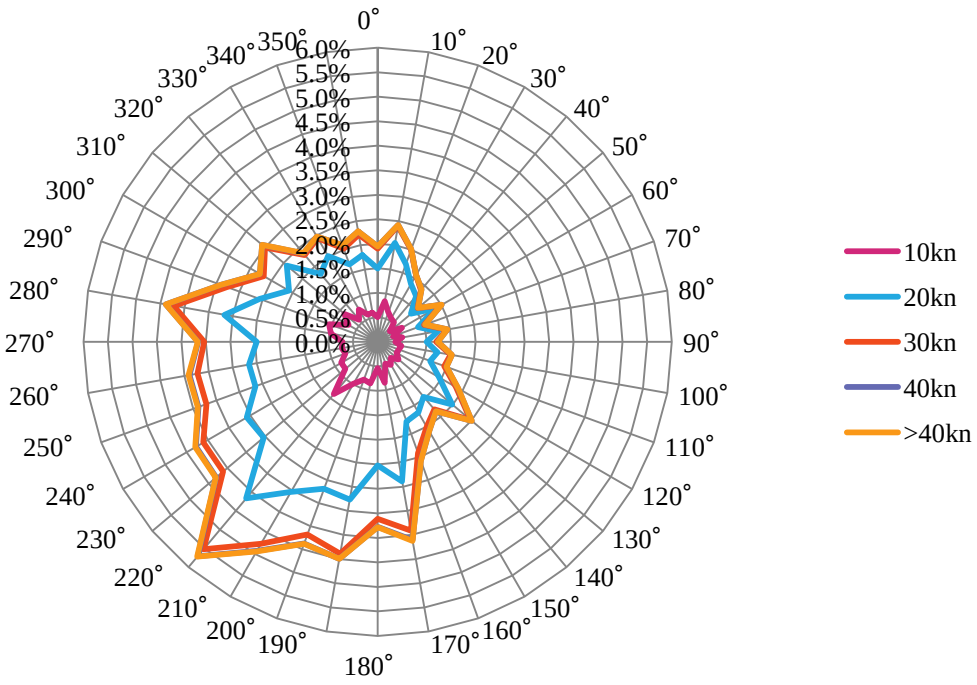

Figure 9 Weather Buoy M1: Wind Rose (2001 – 2007)

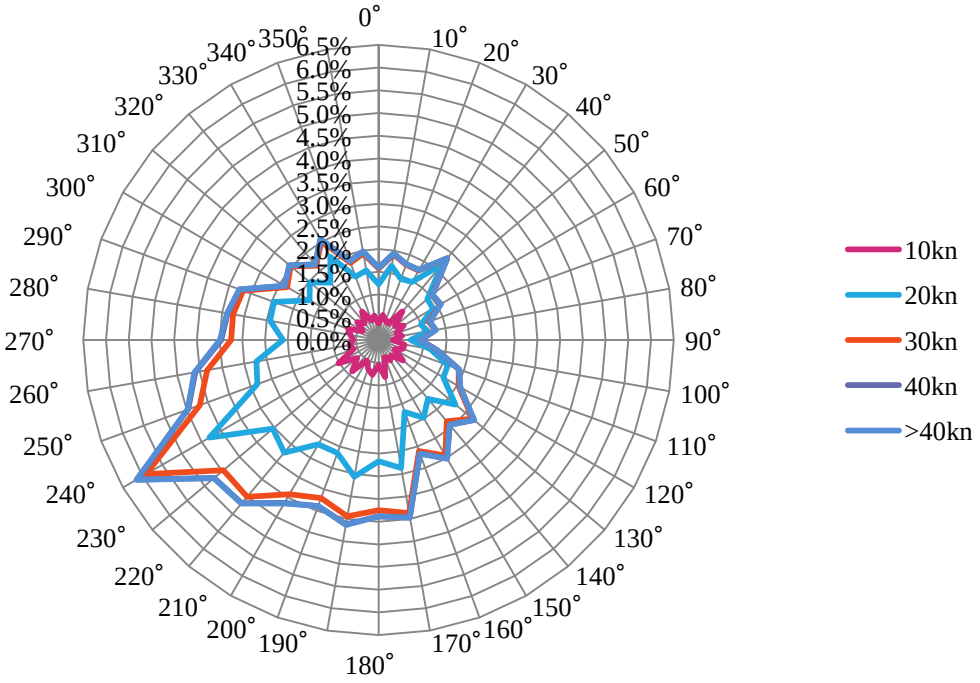

Figure 10 Weather Buoy M4: Wind Rose (2001 – 2010)

Wind speed exceedence curves from the data collected at both weather buoys over the same period are presented in Figure 11 and Figure 12. The average wind speed is 15 knots at the location of buoy M1with 1.1% frequency of winds in excess of 33 knots (Beaufort Force 8: gale force). At buoy M4 the average wind speed is 15.5 knots with 1.18% frequency of winds in excess of 33 knots.

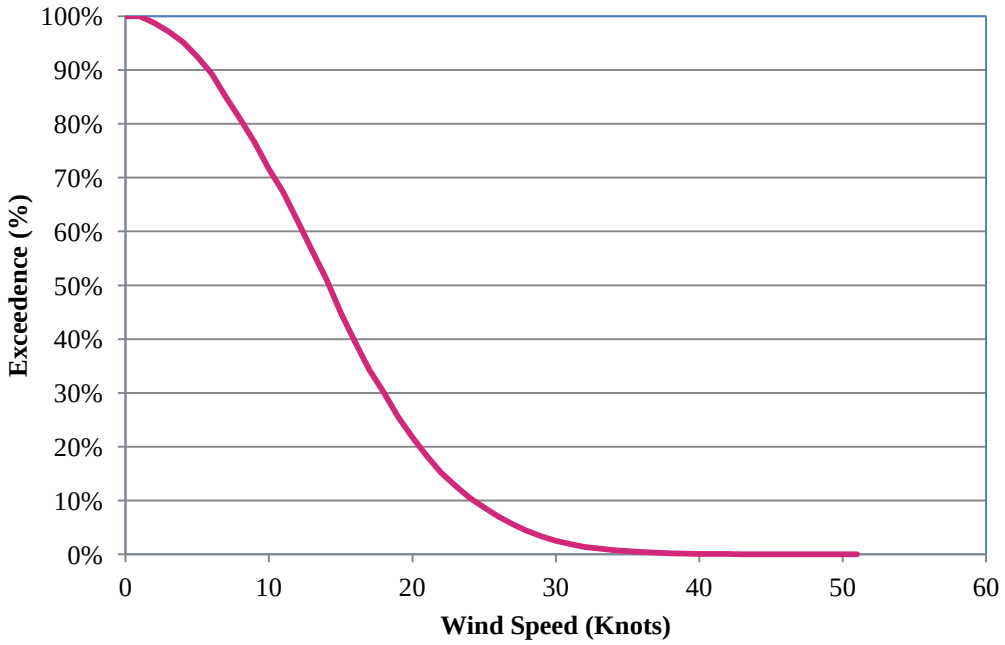

Figure 11 Weather Buoy M1: Wind Speed Exceedence Curve (2001 – 2007)

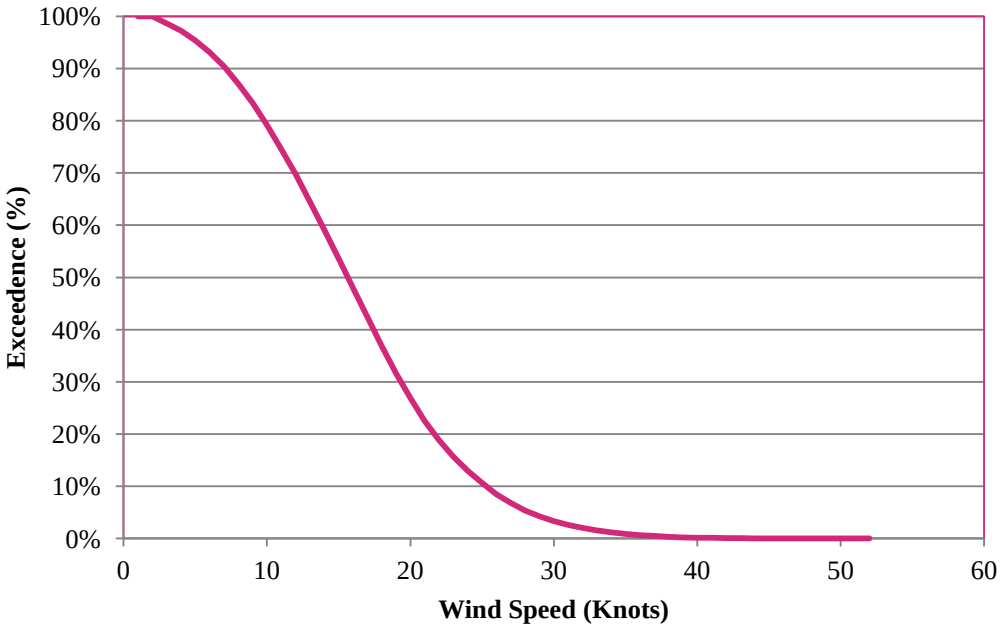

Figure 12 Weather Buoy M4: Wind Speed Exceedence Curve (2001 – 2010)

5.9.2.2 AMETS Wavescan Buoy

In February 2010, the Marine Institute deployed a buoy at the location of AMETS to provide metocean data for the area. Wind data recorded during periods 20/5/2010 to 7/10/2010 and 24/3/2011 to 24/8/2011 is available. Data was not available for other dates due to a number of circumstances e.g. not working properly or brought ashore for servicing.

Figure 13 shows a simple wind rose, as shown for weather buoys M1 and M4, for all data recorded by the AMETS Wavescan buoy to date. The wind rose shows the predominant wind direction to act in the south-south-west (S-SW) direction.

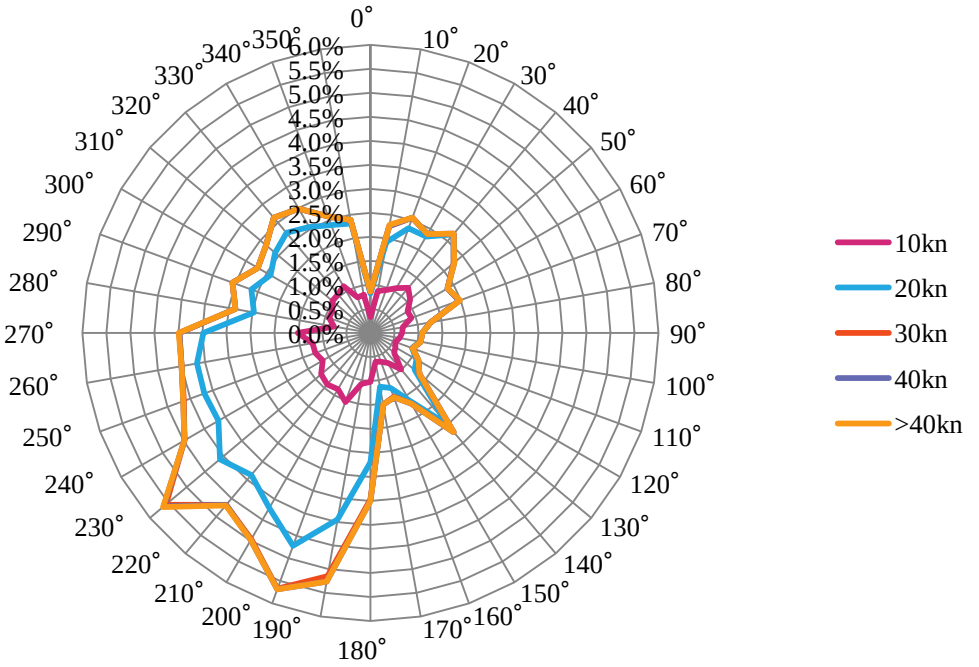

Figure 13 AMETS Buoy: Wind Rose (20/5/2010 – 7/10/2010; 24/3/2011 – 24/8/2011)

A wind speed exceedence curve from the data collected at the AMETS buoy over the same period is presented in Figure 14. The average wind speed calculated using the data collected by the AMETS buoy is 12.7 knots with 0.16% frequency of winds in excess of 33 knots (Beaufort Force 8: gale force). This buoy has only operated for a limited period in winter, which explains the relatively low record of winds in excess of 33 knots.

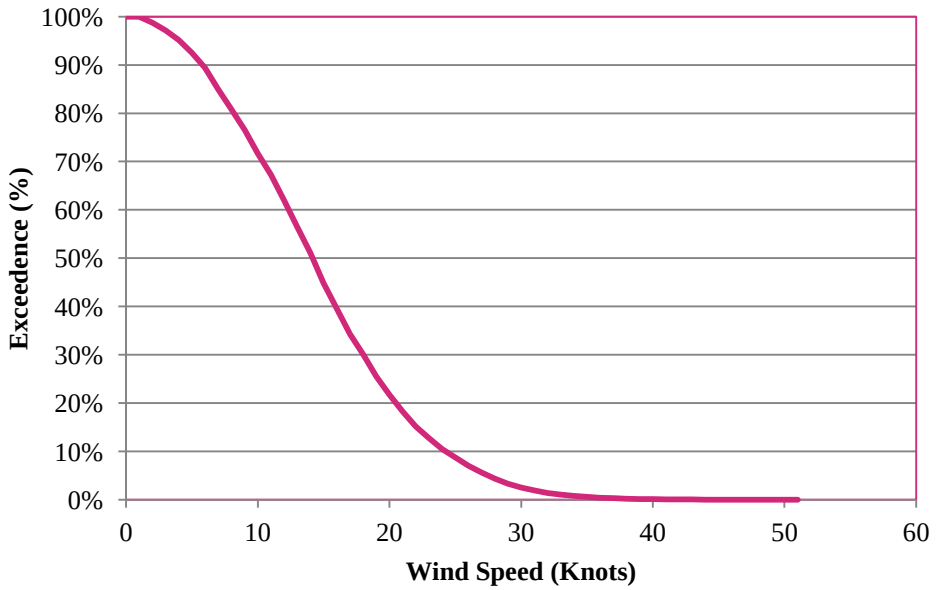

Figure 14 AMETS Buoy: Wind Speed Exceedence Curve (20/5/2010 – 7/10/2010; 24/3/2011 – 24/8/2011)

5.9.3 Visibility

Historically, visibility has been shown to have a major influence on the risk of ship collision. Over the 24 year period from 1983-2006, there were an average of 17 days with fog recorded per year at the Belmullet meteorological station, where fog is defined as when visibility is less then 1km (0.54NM). The distribution of these days throughout the year is shown in Figure 15 below.

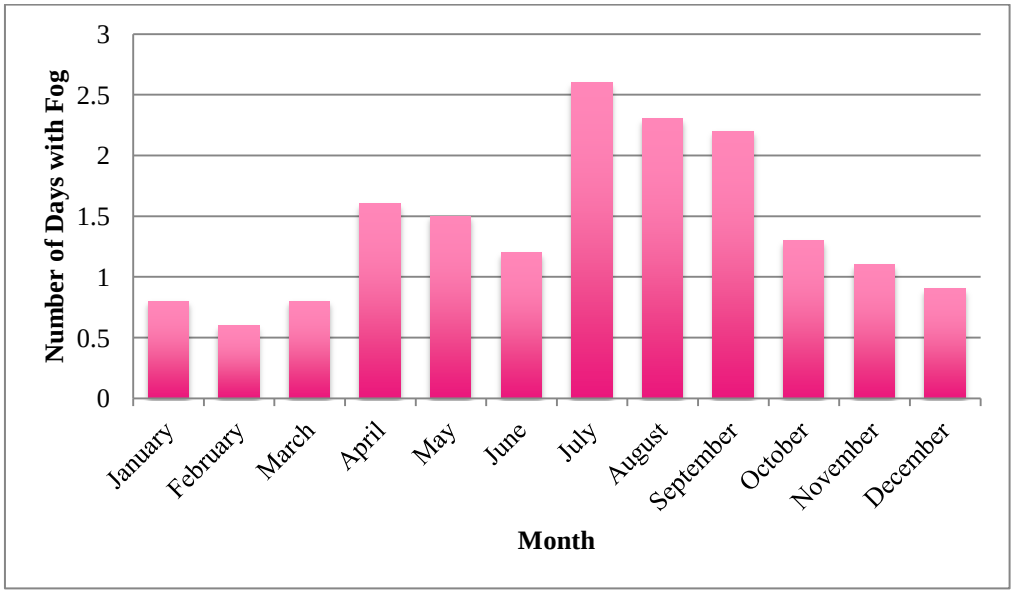

Figure 15 Distribution of days with fog at Belmullet meteorological station

5.9.4 Tide and Currents

5.9.4.1 Tidal Range

The tidal range at Broad Haven is presented in Table 5.1.

	MHWS	MHWN	MLWN	MLWS
Chart Datum	+3.7m	+2.8m	+1.6m	+0.5m
Malin Head Datum	+1.6m	+0.7m	-0.5m	-1.6m

Table 5.9.1 Tidal range at Broad Haven

5.9.4.2 Offshore tidal streams

From the Admiralty sailing directions, Irish Coastal Pilot (ref [5]) the offshore tidal streams are described as follows:

It is probable that the streams affecting the offshore route are similar to those in coastal waters which are weak and follow the general direction of the coast beginning as follows:

Interval from HW (time difference)		*Direction*
Galway	*Dover*	
-0320	*+0300*	*N or NE-going*
+0305	*-0300*	*S or SW-going*

5.9.4.3 Near shore tidal streams

Again from the Admiralty sailing directions, Irish Coastal Pilot the near shore tidal streams are described as follows:

***Between Achill Head and Black Rock**, the coastal tidal streams across the approaches to Blacksod Bay set N and S beginning as follows:*

Interval from HW (time difference)		*Direction*	*Spring Rate*
Galway	*Dover*		*(kn)*
-0320	*+0300*	*N-going*	*1-1½*
+0305	*-0300*	*S-going*	*1-1½*

***Between Mullet Peninsula and the outlying islands** the streams begin at the times given above. The flood stream sets N into the area through the S entrance between the peninsula and Iniskea Islands*

The ebb stream runs outwards in the opposite direction.

The streams are weak in the central part of the area but may attain a rate of up to about 2½ kn off the salient points and in the narrower channels

***West of Inishkea Islands** the flood stream sets NNE in the general direction of the islands*

The ebb stream forms eddies which also set NNE along the W side of the islands and meet the SW-going coastal ebb stream about 1½ miles WNW of Annagh Head (54°15'N 10°06'W)

During the SW-going stream

A race off Erris Head, and ripples or overfalls NNE and ENE, occur when an eddy setting along the coast between Eagle Island and Erris Head meats the main stream.

5.9.4.4 Current Measurements

Current records taken by an Acoustic Doppler Current Profiler (ADCP) at Test Area A from 20/5/2010 to 8/12/2010 indicated the predominant current direction to be approximately NE-SW. The average current velocity in the area was observed as 0.4kn (knots) with a maximum current velocity of 1.5kn.

5.9.5 Wave

A fifteen year numerical based wave climatological study for the AMETS has been performed by Numerics Warehouse Ltd. for SEAI (ref [7]). The study was based on data collected from a number of recording stations located close to the AMETS. Data was recorded every 30 minutes of the 15 year model run at each station. The locations and number of the recording stations can be seen in Figure 16. This study confirmed that the AMETS has a world class wave energy resource right up to the coastline.

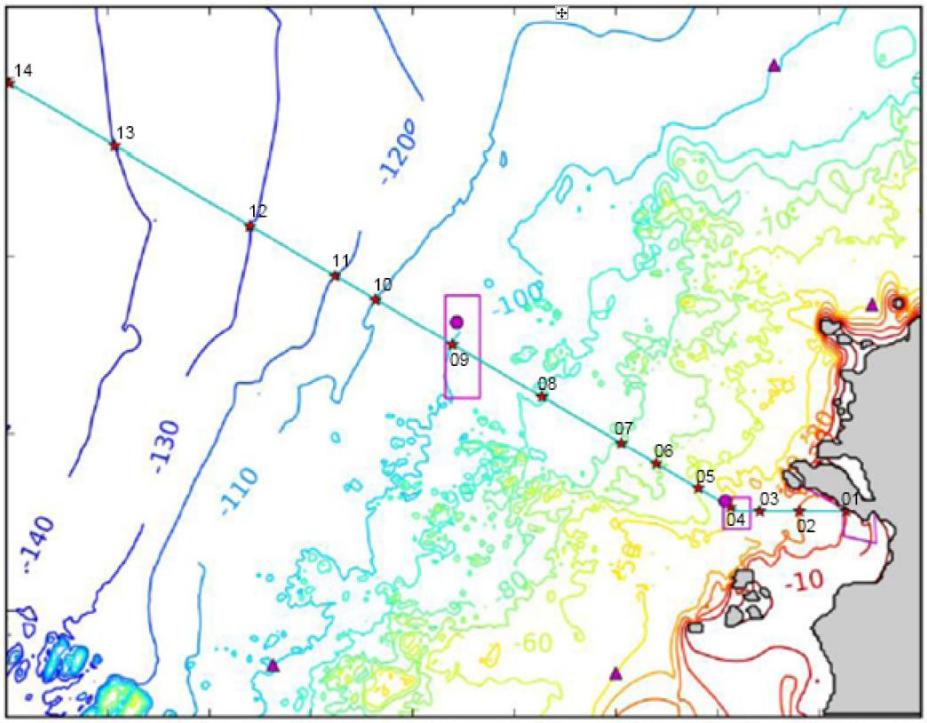

Figure 16 Locations and numbers of recording stations used in wave model

5.9.5.1 Wave Height

Figure 19 and Figure 20 below show the maximum wave heights recorded by the waverider located at Test Area B over the course of 2010 and 2011. Figure 17 and Figure 18 below show the maximum wave heights recorded by the wavescan located at Test Area A over the course of 2010 and 2011.

The maximum wave height recorded at Test Area A was 17.4m, recorded on 23/05/2011. The maximum wave height recorded at Test Area B was 22m, recorded on 11/11/2010. The minimum (maximum wave height recorded at Test Area A and B was 0.7m and 0.3m respectively. The average maximum wave height recorded at Test Area A and B was 3.6m and 4.0m respectively.

Gaps in data in the wave height graphs result from the waverider and wavescan being out of operation at different times during their deployment in the Test Areas.

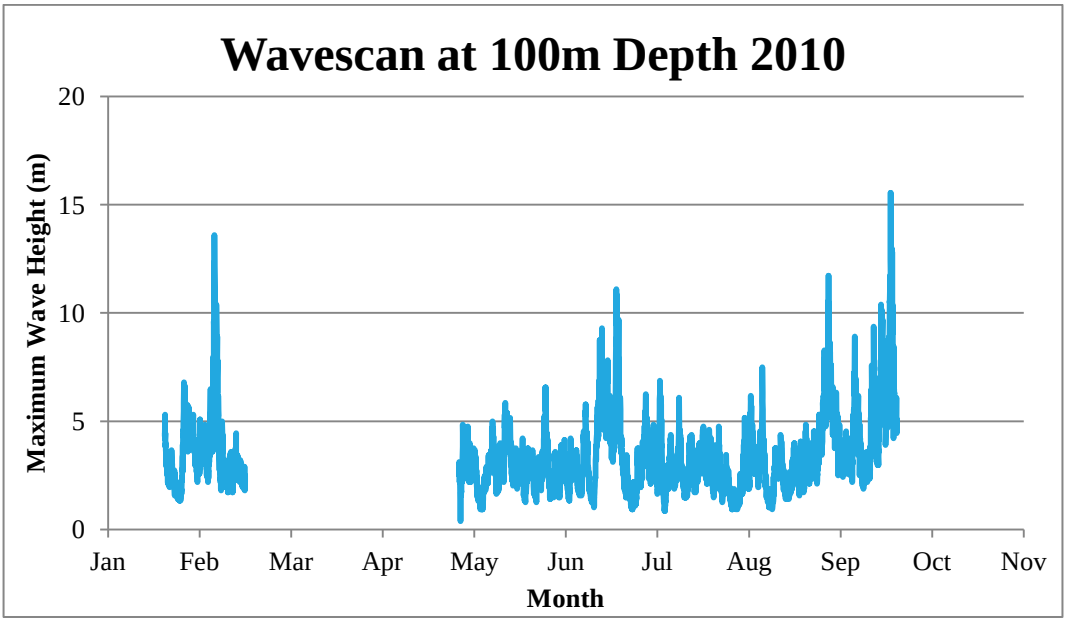

Figure 17 Distribution of maximum wave heights recorded by Belmullet Wavescan at 100m depth (Test Area A) during 2010

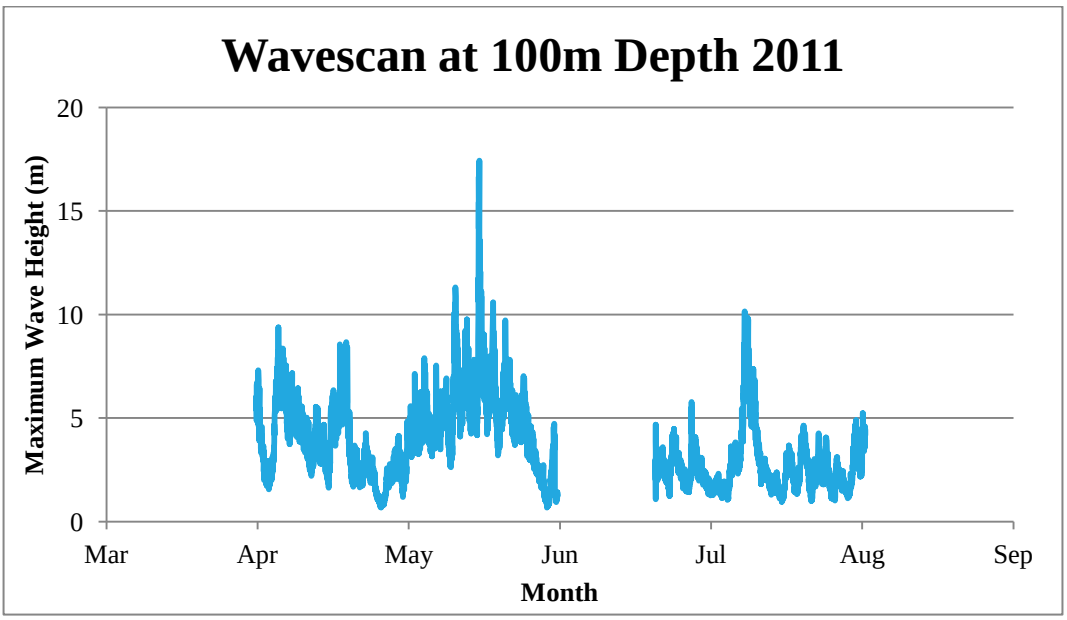

Figure 18 Distribution of maximum wave heights recorded by Belmullet Wavescan at 100m depth (Test Area A) during 2011

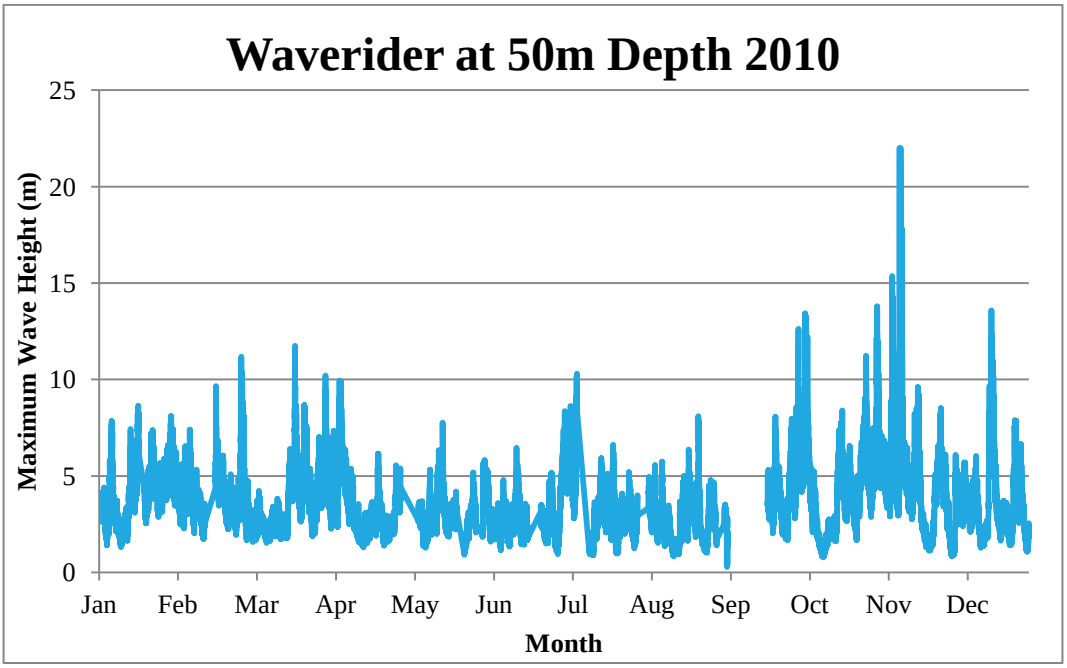

Figure 19 Distribution of maximum wave heights recorded by Belmullet Waverider at 50m depth (Test Area B) during 2010

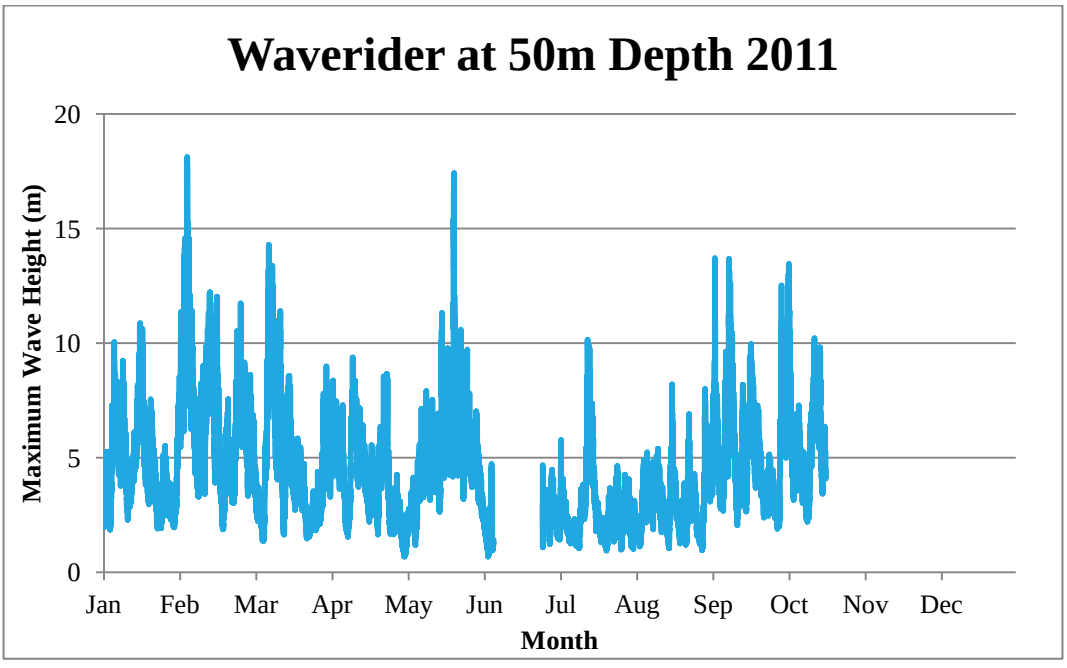

Figure 20 Distribution of maximum wave heights recorded by Belmullet Waverider at 50m depth (Test Area B) during 2011

5.9.5.2 Wave Direction

Wave direction was assessed using the findings of the wave climatological study carried out over a 15 year period. From Figure 21, which encompasses data recorded at Station 07 (depth 70m), it is evident that the standard deviation of

wave direction seems to be highest in the summer months, thus during the summer the wave directions are more varied. During the winter, waves are more uniform and tend to arrive from two main directions – SW and NW.

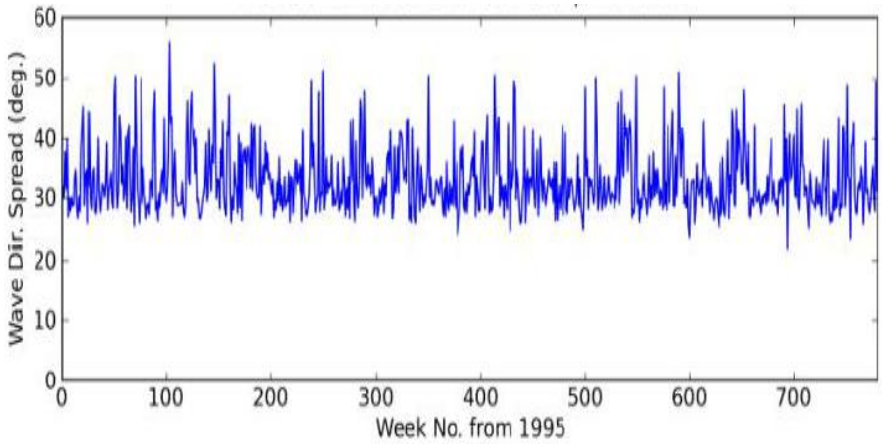

Figure 21 Standard deviation of wave directions recorded at station 07

5.9.5.3 Wave Power

Figure 22 shows a comparison of the omni-directional wave power at an inshore recording station (Station 02; depth = 20m), a mid-domain location recording station (Station 07; depth = 70m) and an offshore location recording station (Station 14; depth = 140m) for the 15 year period included in the wave climatological study by Numerics Warehouse Ltd. The wave power increases very rapidly away from the shore, with a large increase in wave power between inshore and mid-domain stations. However, there is no significant increase in wave power between the mid-domain and offshore stations.

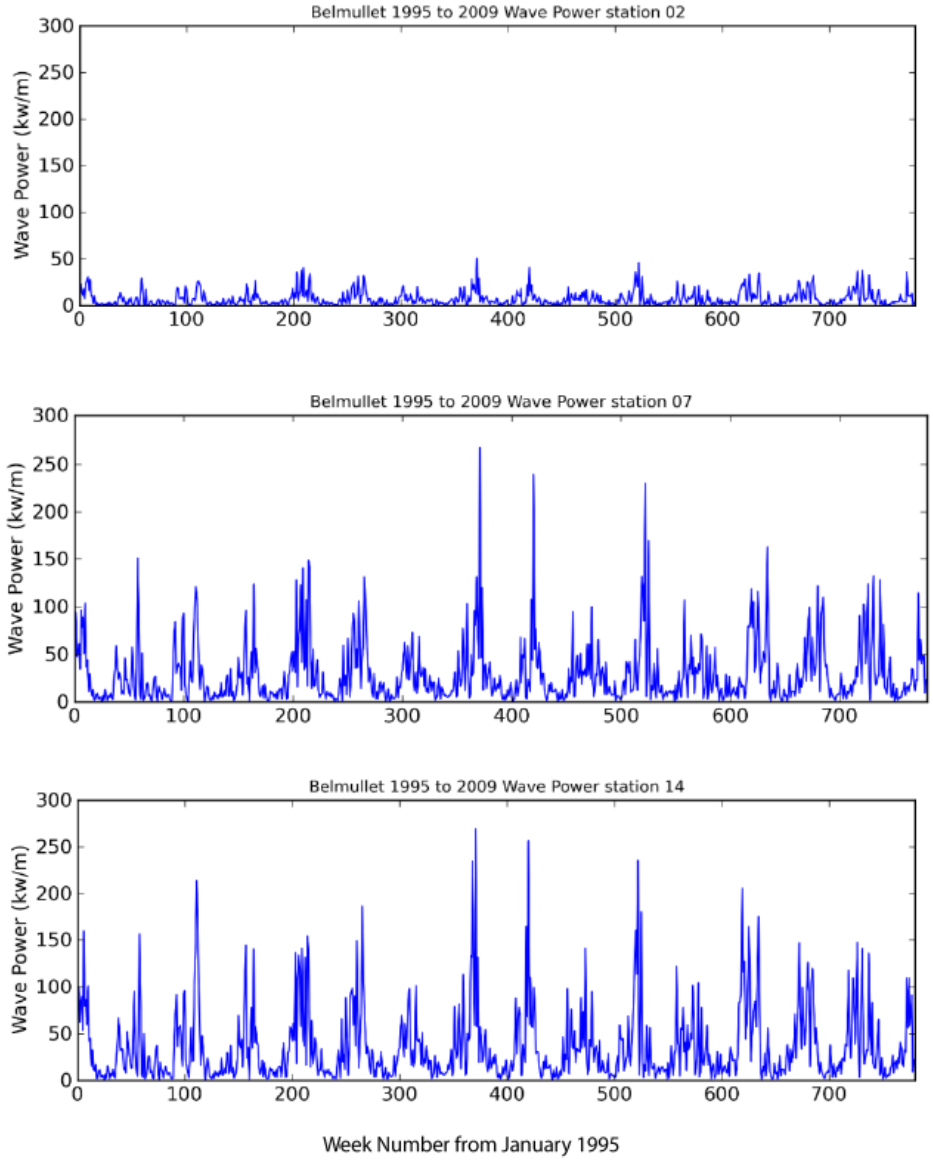

Figure 22 Omni-directional wave power weekly averages for selection of stations at different depths.

The overall mean wave power over the 15 year period is shown in Figure 23.

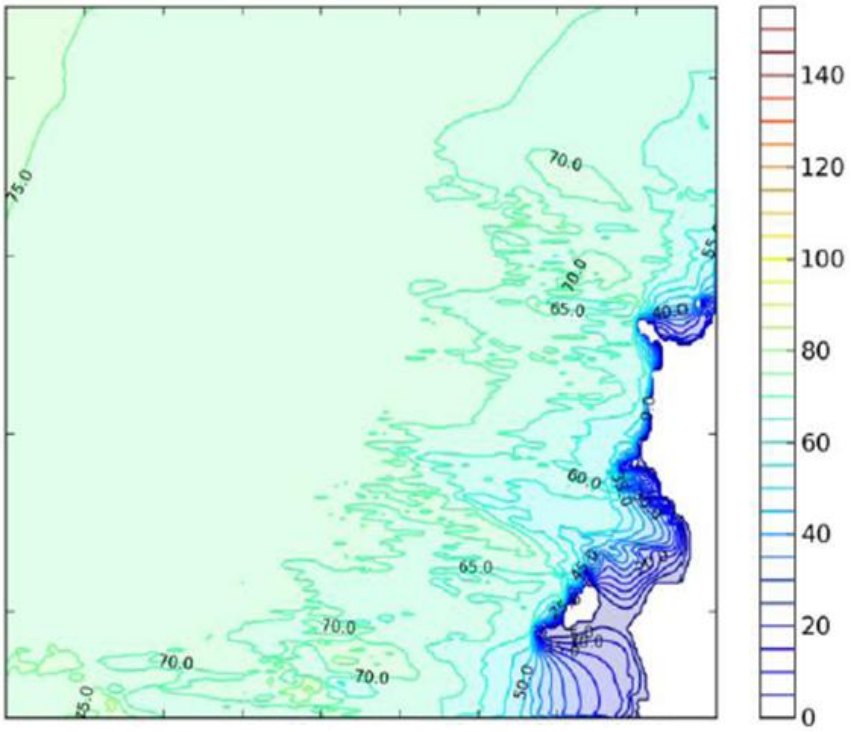

Figure 23 Overall mean wave power for the period 1995 to 2009

Figure 24 shows the wave power exceedence, with data sorted into months of the year, for Station 07 located close to the AMETS. The month of February has consistently over the fifteen year period provided the best wave energy resource, with July providing the least. January is the next best month, and then November and then December. This pattern is more or less repeated for all of the other recording station.

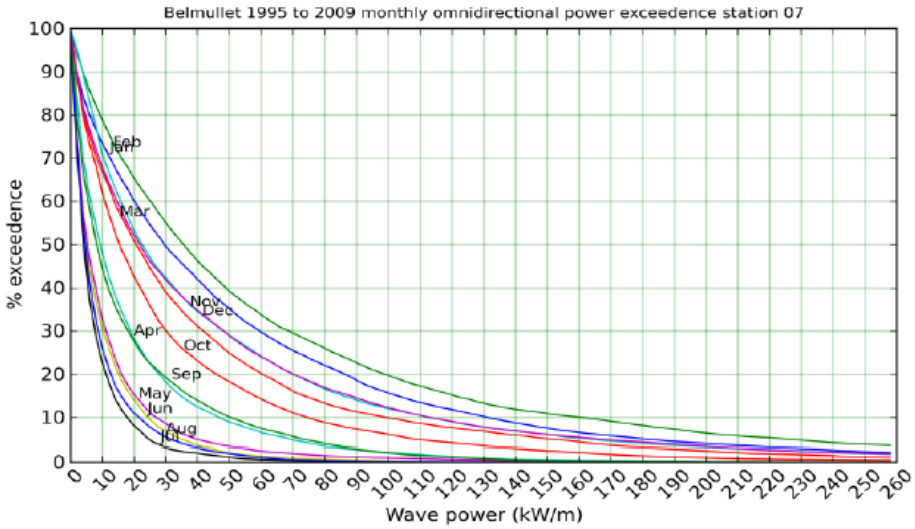

Figure 24 Percentage exceedence of wave power displayed by month for a recording station for the period 1995 to 2009.

5.10 Bathymetry

The bathymetry in the vicinity of AMETS can be seen from Figure 25. Test Area A is located on the 100m contour with no immediate changes in water depth existing close to the test area. Test Area B is located on the 50m contour. The waters to the south of Test Area B decrease in depth quite rapidly due to the presence of Inishglora Island.

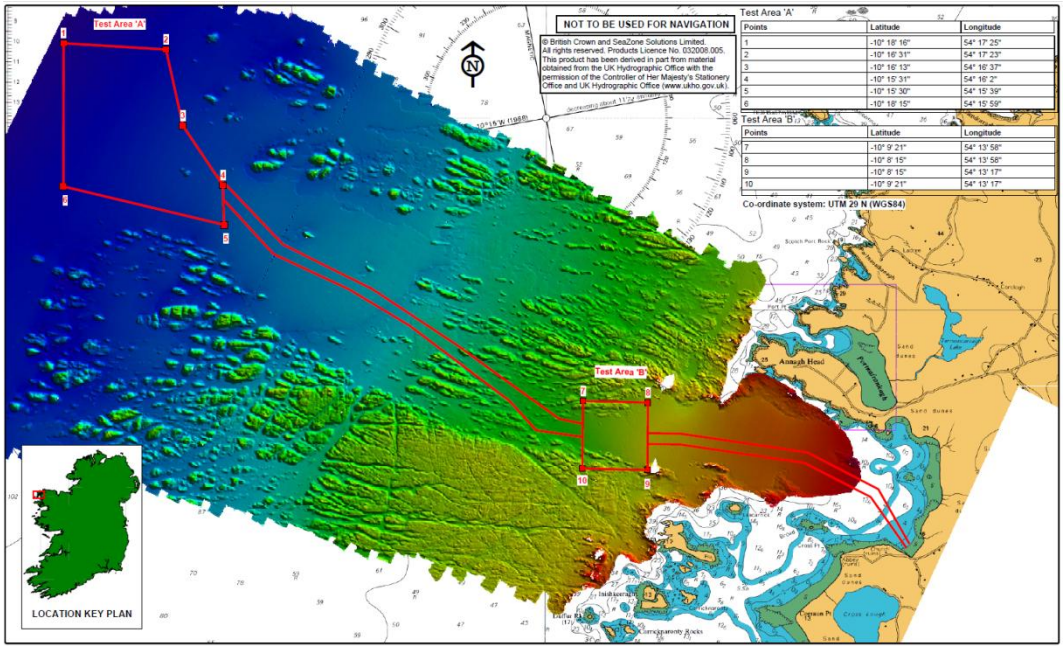

Figure 25 Bathymetry in the vicinity of AMETS

5.11 Fishing Grounds

Inshore fishing is the principal type of fishing in the region of the AMETS and is carried out along the entire coast. There is also Whitefish or Pelagic fishing with larger vessels to the west of the AMETS in deeper waters.

Generally inshore vessels will not travel more than 25 miles west of the mainland when fishing. The fishing effort is largely focused on crab and lobster potting, with some gill netting and trawling.

5.11.1 Crab and Lobster Potting

Potting is a fishing technique which uses small rectangular or half-cylinders shaped ‘pots’ (or traps) to catch crab/lobster. The pots are baited and connected in series and cast (or ‘shot’) and recovered mainly using smaller inshore vessels.

Generally crab and lobster potting is carried out along the sand/rock interface. Potting is limited to the inshore area and depths not greater than 200m, as at large depths crab and lobster may die when the pots are lifted to the surface due to the change in pressure.

Figure 26 presents the area where crab potting is carried out by local fishermen in the vicinity of the AMETS, as roughly indicated by local fishermen. The crabs approach the coast from the deep water to the west. Crab fishing takes place right along the entire coast near the AMETS. There is not usually any crab potting inside of the islands along the Mayo coastline, east of the site. (Inishglora, Inishkeeragh, Inishkea North and Inishkea South). Fishermen from BroadHaven also shoot (cast from the vessel) pots north of AMETS in a bid to try and intercept the crab as they approach the coast from the North West.

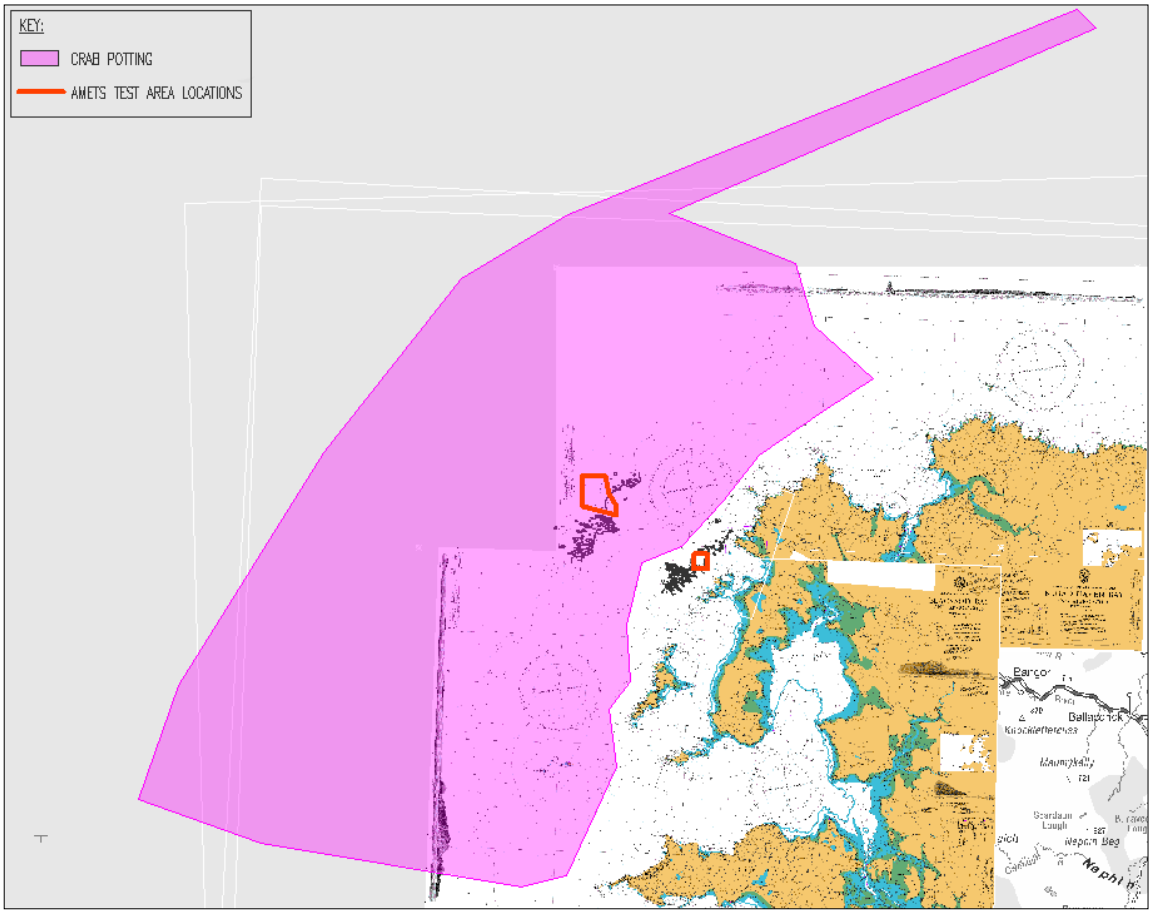

Figure 26 Crab potting area in vicinity of the AMETS

Figure 27 presents the area where lobster potting is carried out again as indicated by local fishermen. The lobster potting takes place particularly close to the coast, as lobster are generally fished on rock.

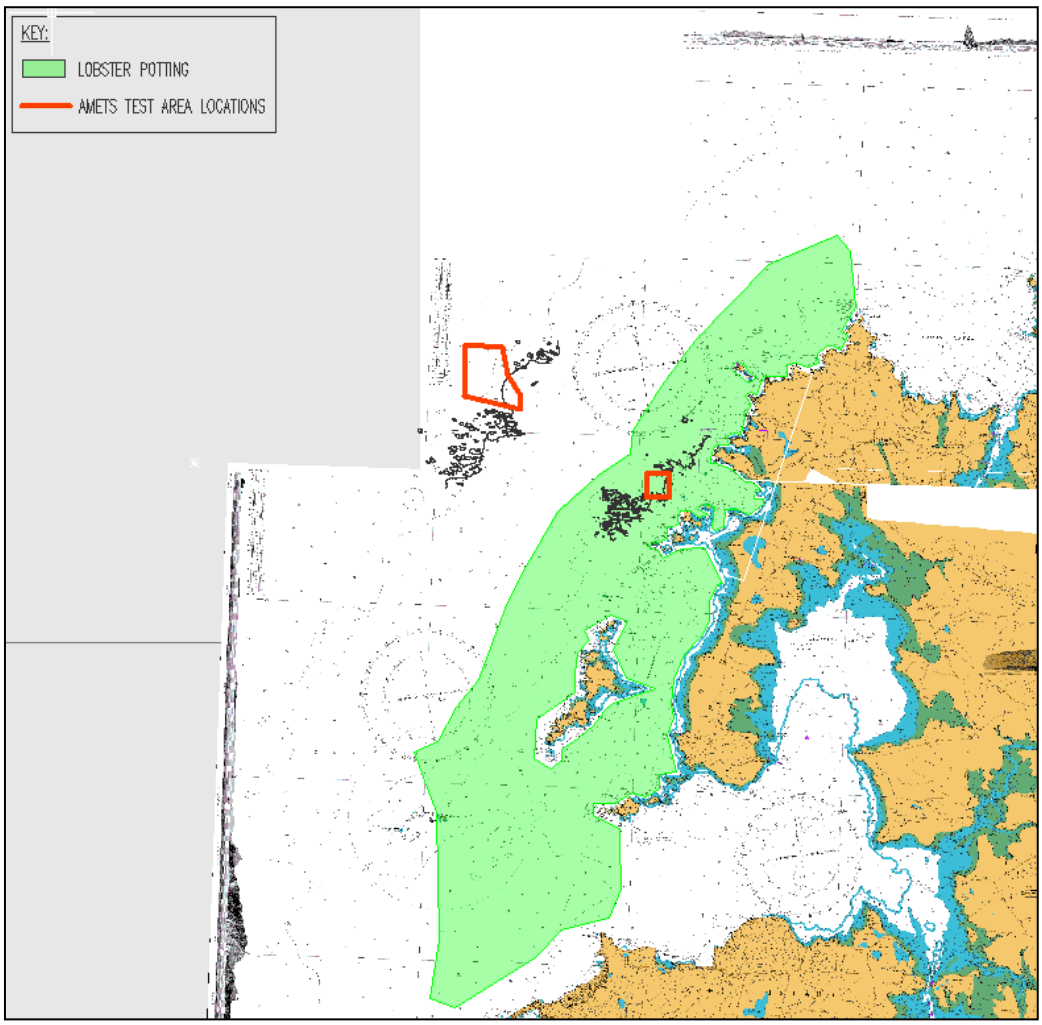

Figure 27 Lobster Potting Area in vicinity of the AMETS

5.11.2 Trawling

Local trawlers fish within the inshore fishing area. Figure 28 outlines a common trawling ground in the region noted by fishermen. This area is used generally by fishermen from Killybegs.

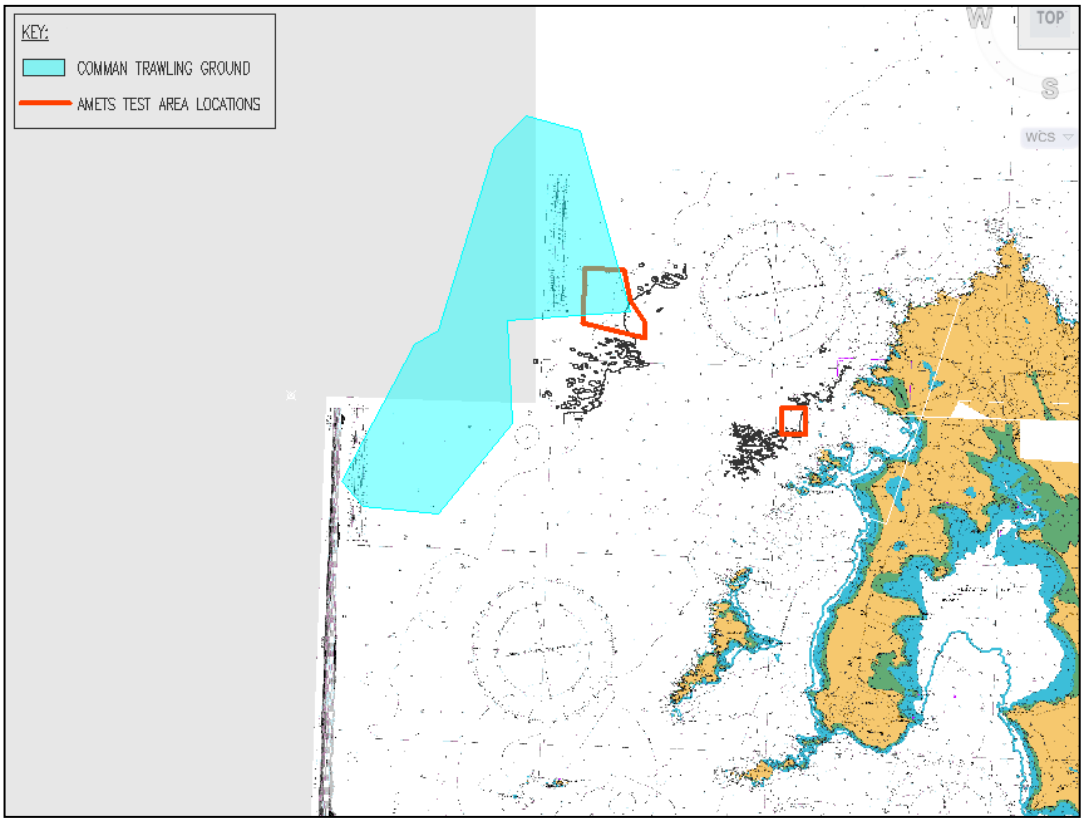

Figure 28 Common trawling ground in the vicinity of the AMETS

6 Consultations

6.1 Introduction

A comprehensive list of navigation 'consultees' has been developed to support this risk assessment. The list includes all groups, organisations and agencies with a stake and/or interest in the waters off the west coast of Ireland, in particular the region off the Mayo coast. This section summarises the responses of the various parties consulted about the AMETS project.

6.2 Navigation Consultees

The following Table 6.2.1 lists the consultees contacted as part of this assessment:

CONSULTEE	CATEGORY
Killybegs Fisheries Organisation (KFO)	Fishing Industry
Bord Iascaigh Mhara	Fishing Industry
EIFA	Fishing Industry
ELCRA	Fishing Industry
Sea Fisheries Protection Agency	Fishing Industry
West Mayo Fishermen's Co-Op (Achill)	Fishing Industry
Galway and Aran Fishermen's Co-op Ltd	Fishing Industry
Irish South and West Fishermen's Association	Fishing Industry
Sinbad Marine	Marine Industry (excl. fishing)
Broadhaven Marine Training	Marine Industry (excl. fishing)
Dúlra Nature Tours	Marine Industry (excl. fishing)
Kingfisher Charts	Marine Industry (excl. fishing)
Irish Sailing Association	Marine Leisure
Achill Belmullet Power Boat Club	Marine Leisure
Club Farraige Iorras	Marine Leisure
Mayo Sailing Association	Marine Leisure
Bellacragher Sailing Club	Marine Leisure
Belmullet Sea Angling Club	Marine Leisure
Belmullet Sub aqua club	Marine Leisure

Dive West Ireland	Marine Leisure
UISCE	Marine Leisure
Irish Cruising Club	Marine Leisure
Irish Kite Surfing Association	Marine Leisure
Irish Windsurfing Association	Marine Leisure
Sligo Yacht Club	Marine Leisure
UK Hydrographic Office	National Authorities/Government Agencies/SAR
An Taisce, The National Trust for Ireland	National Authorities/Government Agencies/SAR
Coastwatch Europe	National Authorities/Government Agencies/SAR
Department of Defence (Navy)	National Authorities/Government Agencies/SAR
Department of Transport – Coastguard	National Authorities/Government Agencies/SAR
Inspector of Lights and Marine Superintendent (CIL)	National Authorities/Government Agencies/SAR
Marine Survey Office (MSO)	National Authorities/Government Agencies/SAR
Department of Transport – Maritime Safety	National Authorities/Government Agencies/SAR
R.N.L.I Ballyglass	National Authorities/Government Agencies/SAR
Department of Agriculture Fisheries and Food	National Authorities/Government Agencies/SAR
Department of Transport – Maritime Transport	National Authorities/Government Agencies/SAR
Shannon Foynes Port Company	Port/Harbour
Greencastle Harbour Master	Port/Harbour
Galway Harbour Company	Port/Harbour
Killybegs Harbour Master	Port/Harbour

Table 6.2.1 List of Consultees

To support the assessment of navigation risk in the area, the above groups were consulted on topics including:

- Marine traffic in the area:
  - Type of vessels – commercial, leisure, authorities
  - Size of vessels – small/large fishing vessels, small/large sailing vessels, rigid inflatable boats (RIBs)
  - Local ports, destinations and sailing routes around and through the area
  - Tide and weather influence on traffic
  - Traffic seasonal changes, present traffic and future traffic
  - Duration at sea – overnight traffic in the area, availing of shelter
- Sea and weather conditions:
  - Worst sea conditions
  - Currents and waves
  - Visibility
  - Rocks, breakers, sand banks/bars, headlands
  - Navigation in bad weather – Aids to Navigation and other navigation aids
- AMETS site:
  - Influence on navigation and sailing routes
  - Influence on navigation of cable laying works to the site
- Accidents:
  - Historical records
  - Cause – poor visibility, engine failures etc.
  - Response – drifting/anchor
  - Rescue procedures – Royal National Lifeboat Institute (RNLI) or other, response time, toeing

6.3 Navigation Information from Consultations

The navigation consultees were divided into the following five categories, as outlined in Table 6.2.1 above:

6) Fishing Industry

7) Marine Industry (excl. fishing)

8) Marine Leisure

9) National Authorities/Government Agencies/SAR

10) Port/Harbour

The following section summaries the relevant information obtained from the navigation consultations.

6.3.1 Fishing Industry

The main source of traffic in this area is from fishing vessels. Consultations with the main fishing organisations (EIFA, ELCRA, KFO) outlined the fishing types, areas, methods, patterns etc.

6.3.1.1 Fishing Practice in the Area

Primarily, the fishing industry in the AMETS region, off the north Mayo coast, consists of inshore fishing (smaller crab and lobster vessels) and larger scale, offshore, Whitefish and Pelagic fishing (vessels ranging 25-40 meters in length).

Inshore Fishing

The general inshore fishing area in the vicinity of the AMETS extends southwards to Achill Island and northwards to include much of Donegal Bay, while boats have been known to travel up to 25 miles west of the mainland. Inshore vessels would not fish further out than the 200m deep water. Inshore fishing is largely focused on crab and lobster potting. The pot is baited with a piece of fish and lowered to the sea floor, with a float and marker rope coming to the surface. Some gill netting and trawling also takes place in the area. A gill net is similar to the surface net, but it uses lighter floats and heavier weights so that the net sinks to the bottom. Haul ropes are attached to marker buoys so that the net can be recovered. Trawling meanwhile involves one or two boats towing a very large net. Of the inshore fishing activities in the area, crab potting is the most significant economically.

Crab generally come in from the deeper waters west and head North East, however the track of the crabs varies from year to year. Fishermen usually set out by picking an area to set the fishing gear (pots) and then moving it until they find where the crab are coming in this year. Pots are usually dropped (shot) while steaming (transiting) into the current and are dragged as they fall through the water column. The pots do not usually drift more than 0.2 miles (400m) off where they are dropped.

Generally the pots will only be hauled and re-baited about twice per week. Depending on weather conditions some boats may leave gear in the water throughout the winter period.

The inshore fishing season extends from March to November, with the busiest time and the best crab catches being during the summer months. A typical lobster boat in the region spends about 120 days at sea whereas a crab boat averages 140 days over the fishing season. Typically the inshore fishing vessels go out fishing in the early hours of the morning (4.00am), stay out the following night and return the following evening. Other vessels may go out at 3.00am and come back in around 7.00pm that evening, avoiding overnight fishing.

In the past on rare occasions some smaller vessels have trawled (using dragnets) in the area west of the AMETS Test Area B, in Annagh bay. This is not a regularly fished area and will not be affected by the location of the Test Area. Vessels will be able to pass North or South of the Test Area B to access Annagh bay.

Inshore crab/lobster fishing inside of the islands along the Mayo coastline, east of the site (Inishglora, Inishkeeragh, Inishkea North and Inishkea South) is carried out only occasionally and this is not a regularly potted area.

Offshore Whitefish and Pelagic Fishing

These larger fishing vessels generally operate all year round and cover a larger area off the west coast, travelling to much deeper waters. This group usually targets specific species and operate a quota system for the stocks they fish which are Whitefish, Mackerel, Herring, Horse Mackerel (Scad). These vessels operate for longer periods of time at sea than the smaller inshore vessels.

6.3.1.2 Navigation

Navigation of inshore vessels

The navigation routes are variable within this region off the Mayo coast. Inshore fishing vessels generally travel a direct route from port straight to where their fishing gear is located. According to the inshore fishermen consulted, the AMETS is not deemed to be of a major significance to navigation in the area, provided it is adequately marked by Aids to Navigation, on charts etc. Vessels will divert their course and travel around the test site areas (A & B).

The inshore vessels travel from piers in Frenchport, Ballyglass (Broadhaven) and Blacksod, with a small number of boats coming up from Achill Island. A large amount of these vessels anchor at Blacksod Pier during the winter as it provides a very safe location where waves are not an issue. Ballyglass meanwhile can get very rough and in the past there have been incidents where chains have broken. As a result, Ballyglass boats generally moor in Belmullet during rough weather.

Navigation of offshore fishing vessels

Larger fishing vessels also fish and transit off the west coast of Mayo. These fishing vessels would include large Whitefish and Pelagic vessels (12-40 meters) which operate all year round.

The fishing areas for these vessels are predominantly to the west of the outer Test Area A. Some trawling grounds exist adjacent to (western side) and within the area chosen for Test Site A.

The larger fishing vessels generally travel a direct route from port straight to where their fishing ground is located. According to the offshore fishing organisations consulted, the AMETS is not deemed to be of a major significance to navigation in the area, provided it is adequately marked by Aids to Navigation, on charts etc. Vessels will divert their course and travel around the Test Area A.

International fishing vessels (Spanish etc.) also travel and fish in deeper waters to the west of Test Area A. These vessels may transit past the site but are unlikely to fish close to the shore.

Visibility and hazards

Visibility in the area changes with the environmental conditions. During summer time extremely heavy fog is common but fog is not a common occurrence in winter. However, visibility in winter can be very poor due to waves and wind. In rougher seas the waves are much larger and this generates noise on the radar. In

heavy fog and low visibility the inshore vessels use global positioning system (GPS) and radar to navigate.

The biggest hazard to navigation in the area is Edye Rock (known locally as "Mainistir") around Annagh head (Figure 29). Other navigation hazards include all of the islands along the Mullet peninsula (Eagle Island, Inishglora, Inishkeeragh, Inishkea North and Inishkea South) and the Usborne Shoal. These hazards are noted on all navigation charts.

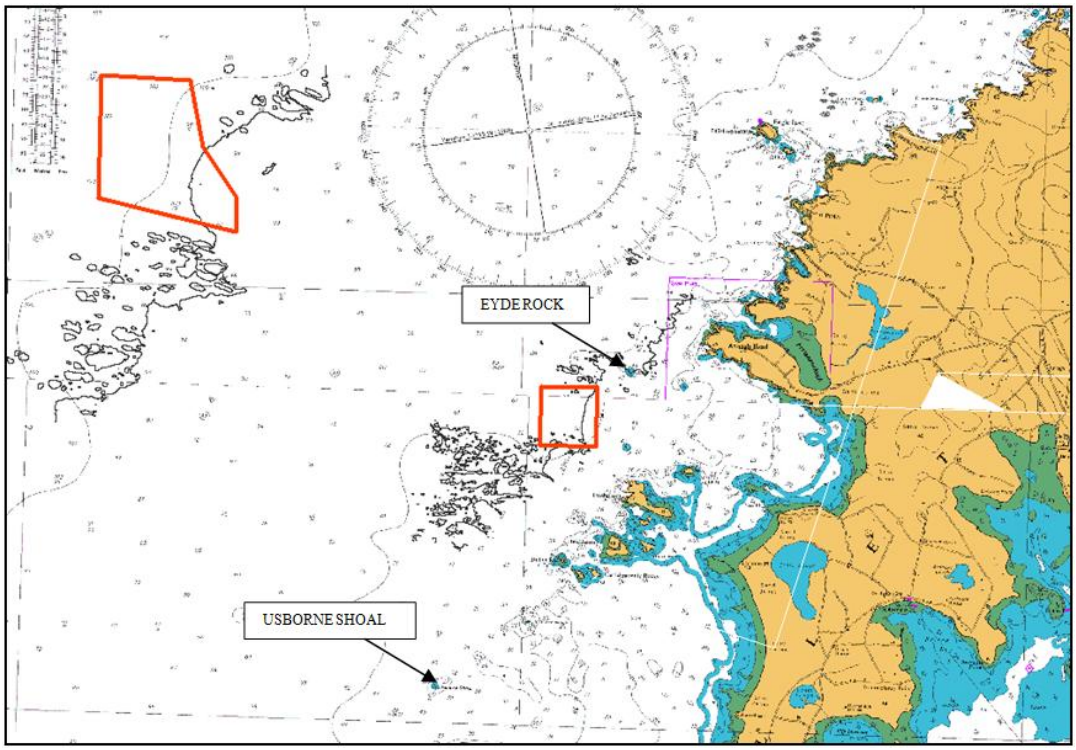

Figure 29 Location of Edye Rock close to Annagh Head.

6.3.1.3 Accidents/Breakdowns

The main cause of break downs reported by fishermen is when a vessel gets "fouled" (when ropes/nets get tangled in the engine propeller).

In the event of a breakdown a vessel will always look to get a nearby friendly vessel to tow it in (possibly even if the friendly vessel is in a port). This means that this type of breakdown/accident is rarely reported and no complete records of breakdowns exist as a result. If a vessel breaks down it will just drift and wait for help. There is not much that can be done when drifting as the vessel is unable to steer. There is no reason to try to moor in deep water (up to 100m). Vessels would wait to be drifted toward the shore before they try to moor. A vessel would drift unless in danger of hitting something or grounding. If the vessel was in danger of hitting something or grounding it would then call for emergency help (Coastguard). Calling for assistance from the Coastguard and RNLI is always the last resort.

According to the local fishermen, in the event of an accident near the AMETS, which required the assistance of the Coastguard, there would be roughly a 1 hour response time from RNLI (considering the mobilisation and 30 minute steaming

from Broadhaven - RNLI station - to the site). These times were confirmed by the RNLI (see section 9.4.3.1)

The smaller inshore vessels reported near collisions with larger offshore fishing vessels and cargo ships. The large cargo ships (and offshore shipping vessels) commonly work on autopilot using a way point system where crew is notified when the vessel needs to change heading. These bigger vessels (trawling and cargo) sometimes hit the inshore fishermen's pots/lines and nets. The inshore fishermen submit the coordinates of their gear to the larger fishing vessels in an effort to rule out these collisions with gear.

6.3.2 Marine Industry (excl. fishing)

Some marine traffic exists in the area, travelling from Broadhaven and Killybegs to the Corrib gas field. There are also small to medium size vessels that trade from port to port, close to the coast in the European area (referred to as 'coasters') and large international vessels that cross the Atlantic or other oceans, normally referred to as deep sea vessels (usually larger than coasters). These larger ships operate on an autopilot system using a standard route. These ships travel along repeated corridors/routes with way points at different locations, for example near the AMETS, west of Eagle Island. Despite sea regulations, there may be no crew observing the radar or the sea. This area off the west coast would be considered relatively quiet waters and ships crew may be less vigilant.

6.3.3 Marine Leisure

The area experiences some limited marine leisure traffic including:

1) Boating and sailing
2) Sea angling and diving
3) Water sports – surfing, rowing, kayaking etc.

6.3.3.1 Boating and sailing

There are a number of local sailing clubs which are located mainly within Blacksod Bay and other bays sheltered to the east of the Belmullet peninsula. Not many sailing yachts from these local sailing clubs travel north towards Eagle Island (and the AMETS site) because of the conditions and lack of shelter/interests. Only very few, experienced sailors from local clubs undertake this route per year (3 travelled north last year 2009 from Mayo Sailing Club in Clew Bay).

Larger sailing yachts from other areas/clubs/countries would traverse this area. Local fishermen noted that approximately 2-3 yachts per day could be seen travelling in the area off the north Mayo coast during the summer time and up to the end of September. A wide range of yacht sizes sail in the region generally 30-60/70ft yachts (9-20m). The yachts tend to be international as much as Irish vessels. These yachts are free to travel as they please and follow no fixed route. Frenchport Bay is a popular anchorage for yachts going round the coast since it is right on the main track and a convenient point of departure for the long crossing to west Donegal. There is also a round Ireland race that takes place every 2 years.

The Irish Sailing Association (ISA), the Irish Cruising Club (ICC) is preparing a database of the routes and areas used by leisure craft, and of the density of this traffic for the Republic of Ireland. Figure 30 below shows the ISA-ICC sailing information for the area of interest off north Mayo.

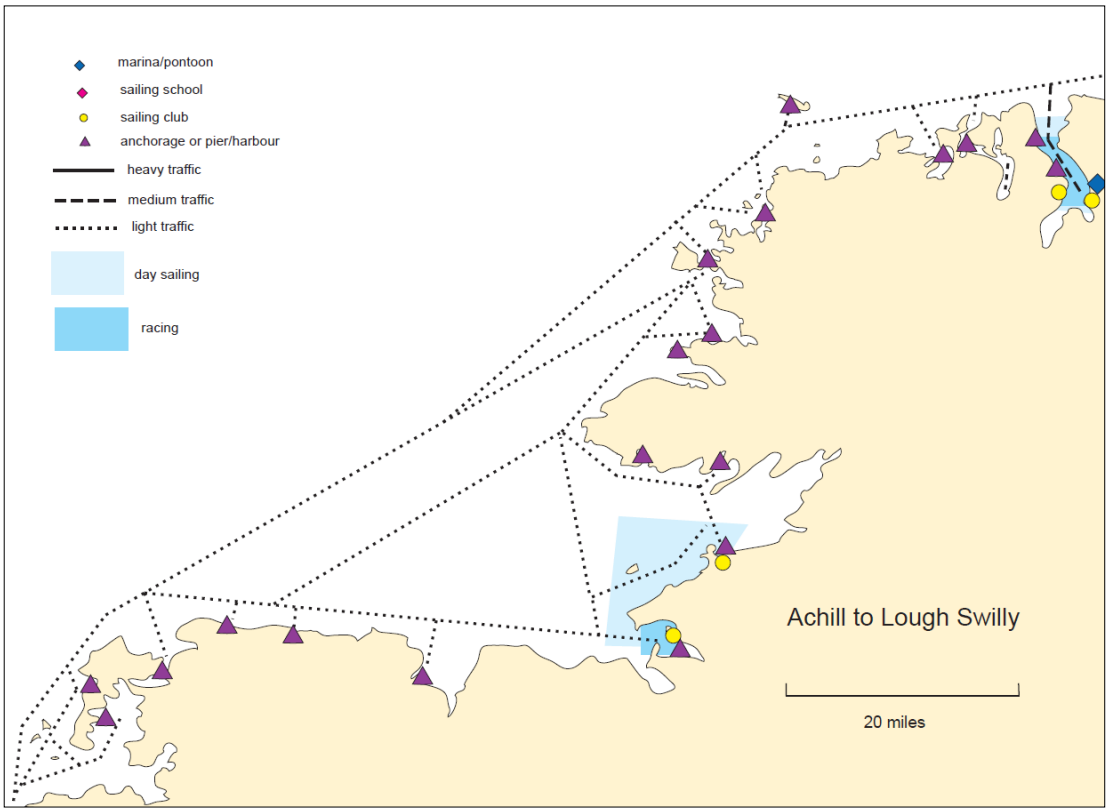

Figure 30 ISA-ICC Sailing Information for North Mayo

Test area "B" north west of Inishglora is on or close to a route followed by yachts sailing round the coast, but this should not present a problem. The traffic density of leisure craft in this area is extremely low, and the detour to pass west of the test area is not significant. In clear weather and daylight, the passage inside Inishglora is often used, but in poor visibility, heavy swell or darkness, a yacht is advised to stay well outside the islands.

Test area "A" is well to the west of any usual track for leisure craft but the same marking considerations apply. Submarine cables are not a problem here.

Sailing vessels travelling in this area work off winds and headlands for their route. The crew of the yachts that travel in this area is generally experienced and skilled at navigation as they cannot risk collision and they are vigilant as they may not be familiar with the area. In terms of navigation, the only perceived impact is that the Test Area A & B will cause users to change course. The sailing associations consulted have outlined that the following will also need to be provided:

a) the site to be marked on navigation charts,

b) marked by adequately sized buoys using AIS, lighting etc. especially at night

c) any site activity to be included in radio navigation warnings and notice to mariners and;

d) any site activity to be published on the hazards list at end of the sea area forecasts, if required.

6.3.3.2 Sea angling and diving

Sea angling and diving associations in the area have noted that there is some use of the area however, it would not be affected by the AMETS project in terms of navigation.

6.3.3.3 Water sports

The site will not affect navigation for water sports in the area. The cable laying construction works may have an impact on users of the beach at Annagh.

6.3.4 National Authorities/Government Agencies/SAR

6.3.4.1 Test Site

According to the Coastguard in the region there are no reasons why a ship cannot pass either inside or outside the location of the Test Area A. There is a large gap (approximately 4.2NM) between the Test Area A and Test Area B which is considered more than enough for a ship to pass through.

There will be a requirement to include the AMETS on admiralty charts which can be carried out by contacting United Kingdom Hydrographic Office (UKHO). The Marine Survey Office (MSO) meanwhile can update the location of AMETS on navigation charts and they can also publish notices to mariners in relation to the site if required.

It is not foreseen that any notable increase in ship traffic will occur in the future. There is the possibility of the test site becoming an attraction and people may tend to go out and have a look at it, especially when devices are being tested.

There is no traffic segregation/separation scheme in place, thus sailing routes in the area are as preferred by each vessel. The proposed Test Areas A may be in a commonly used sailing route. However, the coastguard feel that attempts to move the Test Area A towards the coast would increase navigation risk as it would create a narrower sailing channel on the landside of the site. In its current form, there is adequate room for vessels to pass safely on the landside of the Test Area A.

During an operation the RNLI have no specific routes, they travel direct to any incident thus are required to know the exact locations of all objects in the waters to prevent a collision. The test areas are an obstacle to SAR but this would not be seen as an issue. As with fish farms, other vessels or natural features (e.g. shallows, rocks etc.), the RNLI will live with this and work around it.

If a WEC device broke loose from its moorings, the RNLI would intervene only if it was a danger to navigation but not for saving the device itself. They would not be in a position to tow a device but would contain (hold in position) it while waiting for assistance. The device would require a larger tug vessel for towing.

6.3.4.2 Test Site Marking

An important aspect of the development noted by the organisations is the marker buoys/lights. The Aids to Navigation must be up to the standard for open waters and approved by CIL. The RNLI note that 8m swell can occur in the area and make visibility very difficult. A standard harbour area light will not suffice as a result. A very high mast buoy will be required (3-4m mast is not sufficient). In rough weather, high waves generate a large amount of noise on the radar and may hide the buoys if they are too small. Also buoys will be out of sight in the trough of the waves. It is paramount that buoys are equipped with good radar reflector and reflecting materials/panels. All effort must be made to mark the site using Aids to Navigation, charts, radio navigation warnings, notices to mariners etc..

The layout of Test Area A impacts on the type of marking that can be used. The marking of the area, what buoys are used and how it is noted in the charts will all need careful consideration due to the irregular shape of the area. The type of marking considered at this stage is outlined in section 9.3.3. This marking will be finalised on consultation with the relevant statutory bodies.

6.3.4.3 Potential Hazards

Local fishermen and boat users are likely to navigate as they like but are also likely to be the most informed about the test site, thus the RNLI would not see them as the highest risk to safety.

Sail boats are generally the lowest risk to a navigation hazard such as the test site. They are very capable navigators and have a very good knowledge of the charts and notices. They use the land to navigate so are constantly on watch. They are the most careful because they cannot afford to make any mistake in such exposed waters. Yachts are the main boats that would travel landside of the sites.

The main risk to safety of vessels and the test site, perceived by the RNLI, is posed by the ’coasters’ and deep sea vessels that travel along the coast from international waters. These ships, as mentioned earlier, do not have the benefit of local knowledge and use an autopilot system. It is anticipated that when the AMETS is marked on the Admiralty charts and referenced in the various pilots, these vessels autopilots will be programmed to avoid Test Area A (and B) at a safe distance. The key issue is that vessels navigating in the area must have up to date charts, radio navigation warnings must be issued for a substantial period of time before and after the sites are developed and the sites must be well marked.

There should be no risk to the installations such as cables as these areas will be marked on charts as “no anchor” areas. However, in an emergency a ship would anchor here regardless.

Hazards other than vessels would include floating containers (RNLI brought in 2 containers in the recent past) from cargo ships and marker buoys which have left their moorings. Containers would not be easily seen on radar (air draft of 0.5m).

The anchoring lines from buoys and devices may attract certain fish. If this is the case, there may be a tendency for fishermen to fish closer to Aids to Navigation along the site boundary. This may increase the likelihood of an accident near the test site.

6.3.5 Port/Harbour

No response received.

7 Maritime Traffic Survey

7.1 Introduction

According to the MCA (Maritime and Coastguard Agency) Marine Guidance Note 371 (ref [2]), a maritime traffic survey of the proposed development area concerned should be undertaken within 12 months prior to submission of the Environmental Statement.

The maritime traffic survey should include all the vessel types found in the area and is likely to total at least 28 days duration. It is important to take into account seasonal variation in traffic patterns, and fishing operations. These variations should be justified in consultation with representative recreational and fishing vessel organisations, and, where appropriate, port and navigation authorities.

7.2 Survey Details

A 28 day maritime survey was carried out in the vicinity of the AMETS. To account for seasonality the survey was carried out over two separate survey periods as follows:

- Winter Survey - 26th November 2010 to 10th December 2010
- Summer Survey - 23rd May 2011 to 14th June 2011

7.2.1 Winter Survey

The Winter Survey was carried out from a location at Doonamoe blowhole to the NW of Belmullet, Co. Mayo (54°15′53.96″N, -10°4′34.10″E). The location of the survey site relative to the AMETS is presented in Figure 31.

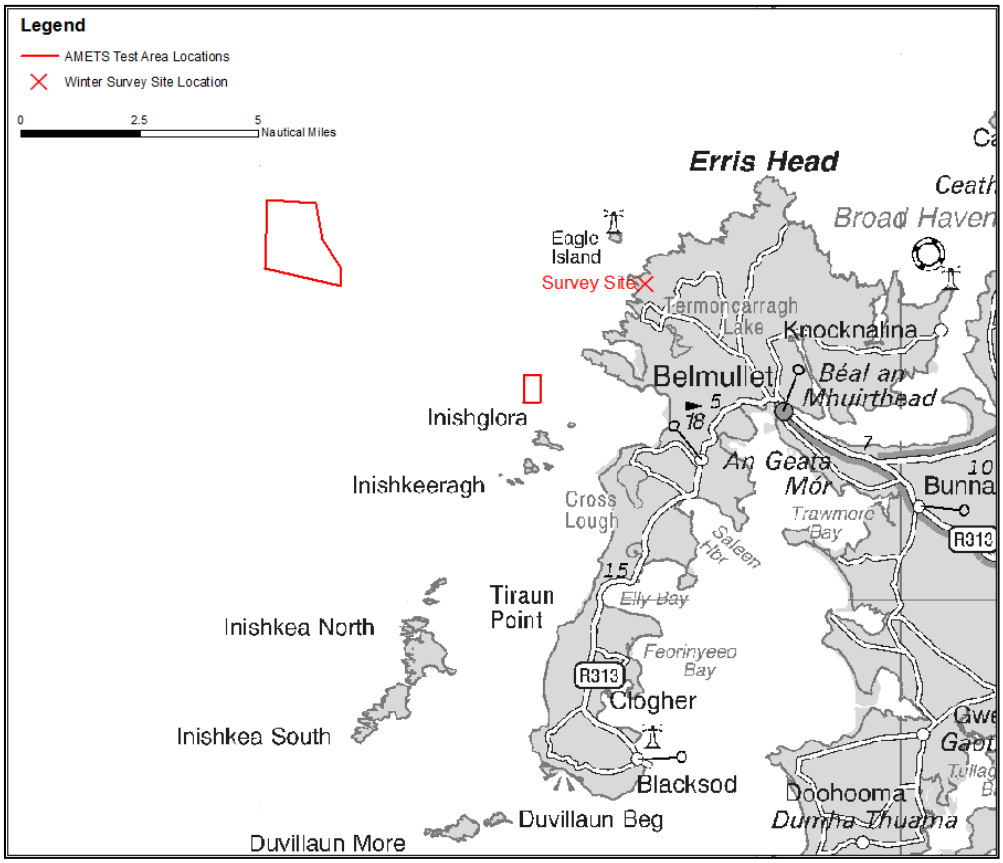

Figure 31 Location of survey site during Winter Survey

In total the Winter Survey was undertaken for 15 days. However, the radar survey was suspended for a period of 51 hours at the request of SEAI. As a result this period of the survey is excluded from the general analysis, and only a net duration of the survey of 11days and 21 hours is considered.

Mixed weather conditions were experienced over the course of the survey. The survey period began with wet conditions and high winds which were followed by heavy snow that occurred towards the end of the first week. The wet and windy conditions returned as the survey ended. The wind reached a maximum of Force 9 Beaufort (46 knots), averaging between 2 and 3 Beaufort (6.8 knots) over the course of the survey.

7.2.2 Summer Survey

The Summer Survey was carried out from Eagle Island lighthouse off the coast of Co. Mayo (54º16. 991′N, -10º5.573′E). The location of the survey site relative to the AMETS is presented in Figure 32.

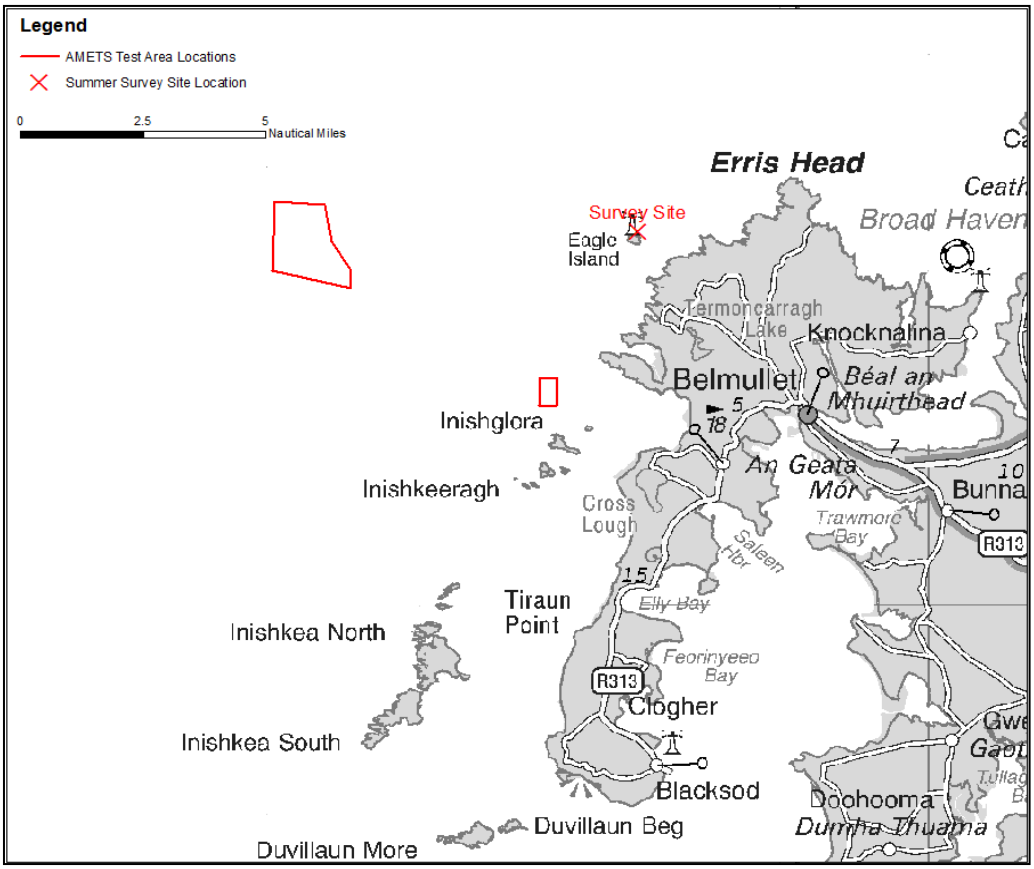

Figure 32 Location of survey site during Summer Survey

In total the Summer Survey was undertaken for 23 days. Initially the Summer Survey was to take place for a 14 day period but, due to exceptionally bad weather conditions experienced during the first number of days of surveying, the survey period was extended. As a result it was decided not to use the data recorded over the first number of days in analysis as it would not reflect the usual maritime traffic in the area. The general analysis therefore includes the data recorded from 09:30 on 29th May 2011 to the end of the survey period which is a total of 16 Days and 3 hours.

The second survey period included in analysis was carried out in generally dry conditions and low to moderate winds. The wind reached a maximum of Force 8 Beaufort (39 knots), averaging between 3 and 4 Beaufort (11.0 knots).

7.3 Survey Data Collation

7.3.1 Area of Interest

Traffic beyond the 10 NM horizon from an offshore installation is normally considered neither to have any effect nor to be affected by the same installation. In view of this, the traffic analysis is therefore usually limited to the area within a 10 NM radius from the site.

For the AMETS a slightly larger limit in some areas was chosen to extend the validity of the assessment. The Area of Interest upon which the traffic analysis was carried out covers a minimum of 10 NM from any point on the boundary of Test Area A as shown in Figure 33. This Area of Interest is sufficient when assessing the impact of the AMETS installation.

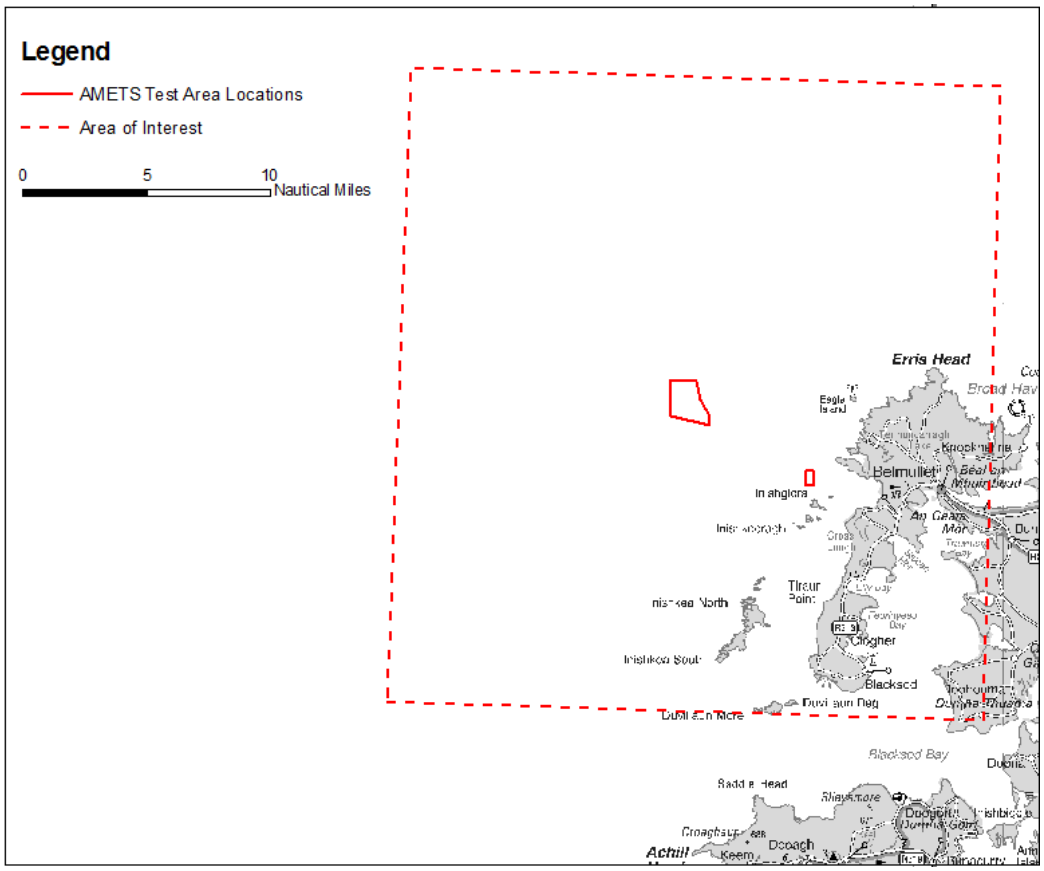

Figure 33 Area of Interest surrounding AMETS chosen for Analysis

7.3.2 Methods of Vessel Track Detection

The survey data was collated using a combination of three main sources including:

- Automatic Identification Systems (AIS)
- Shore-Based Radar
- Visual Observations

Vessel Monitoring Service (VMS) data was received for the area in the vicinity of AMETS. However due to the large time interval (2 hour) between successive recordings of location points of a vessel it was felt that this data would not benefit this navigation risk assessment

7.3.2.1 Automatic Identification Systems (AIS)

AIS enables vessels and Coast Guard shore stations to transmit and receive information regarding identity, position, course and speed of vessels. AIS transmissions and information is broadcast over VHF radio and is freely available to those with AIS monitoring equipment. AIS is compulsorily carried by commercial vessels of more than 300 gross tonnes but can be used by small craft as an additional safety feature.

AIS is a very accurate method of detecting a vessels location and the track they are travelling. The AIS monitoring carried out for this survey proved straight forward requiring only a simple system including a receiver, an aerial, a GPS receiver and a computer.

There was little restriction to the range from the survey site in which AIS data could be recorded thus vessel tracks recorded by AIS are available for the entire Area of Interest around the test site and beyond.

7.3.2.2 Shore-Based Radar

Shore based radar offers reliable detection of small maritime vessels. Radar provides information on position and course of vessels. By utilising microwave radars, continuous offshore surveillance can be carried out establishing locations of vessels within a certain area of the on-shore survey site. As shore-based microwave radars operate in line-of-sight mode, they cannot detect and track vessels beyond a certain range.

The shore-based radar detection which took place during both survey periods detected accurately the position of vessels. However the detection range of the radar was limited as can be seen in Figure 34 and Figure 35. The range within which a vessel is detected depends heavily on the size of the vessel being monitored. A large steel hulled ship will be detected at a much greater range from survey site than a small pleasure craft. The range acquired by the radar equipment can also depend on the weather conditions with the radar usually recording further during fine periods of weather.

The radar during both surveys also detected some of the large vessels carrying AIS at greater ranges then seen in Figure 34 and Figure 35 but in order to remove duplications, AIS tracks have overwritten radar tracks when both have been acquired for the purpose of this survey.

The maximum approximate range in which a vessel was recorded by radar during the Winter Survey was 20NM shown in Figure 34. The vessels with the longer ranges are almost exclusively in transit through the area. They have been defined as fishing vessels however they are not actually engaged in fishing. These are large trawlers which are navigating to/from offshore fishing grounds; these are large steel hulled vessels. Despite the rules on AIS carriage and operation many fishing vessels do not switch them on, thus these vessel tracks are not recorded by AIS.

During the surveys, the radar was sectored (detection not taking place through full 360º rotation) to focus the scan area over the water only. The area to the NE of the AMETS as a result is not within the radar detection area.

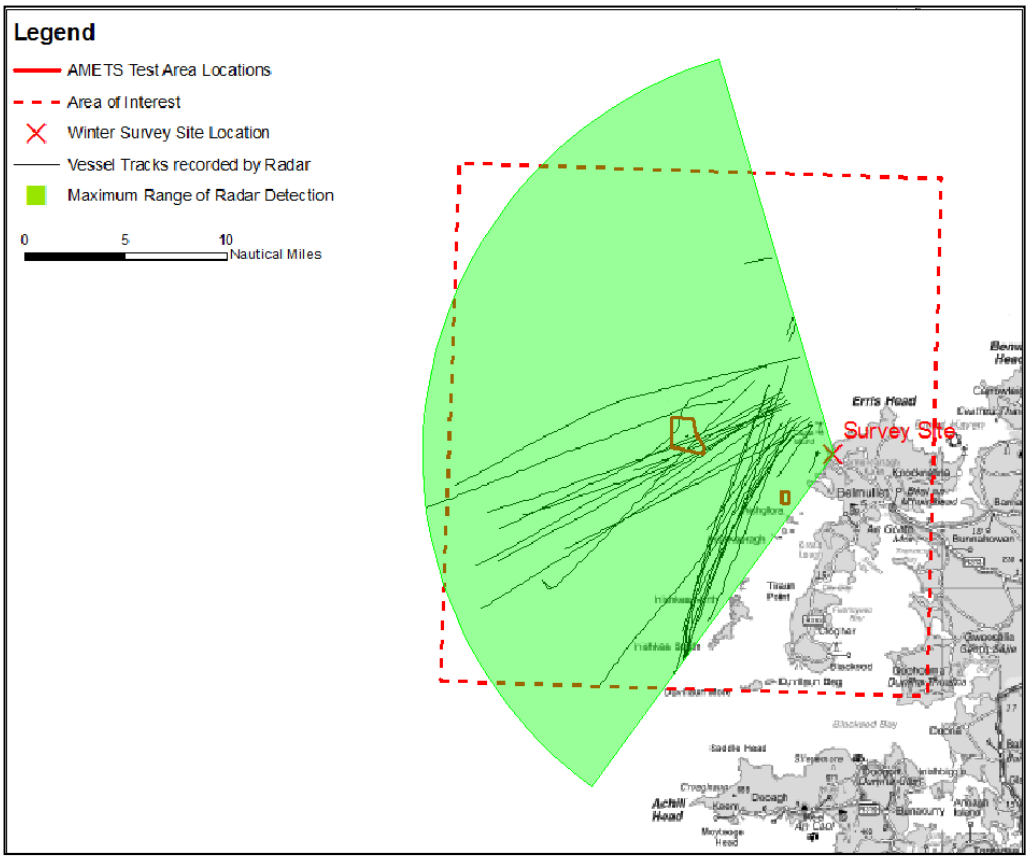

Figure 34 Maximum approximate range of radar detection during Winter Survey

During the Summer Survey, the maximum approximate radar detection range in which a vessel was recorded was 12NM. Figure 35 shows the zone containing radar tracks is less than previously achieved during the Winter Survey. This is due to the fact that the transits through the area by large fishing trawlers, which because of their size were recorded at greater ranges during the Winter Survey, appear to be seasonal and are not present during the Summer Survey. Figure 35 indicates that there was a lot more local fishing activity present along the inshore area during the Summer Survey period. The radar was again sectored while carrying out the Summer Survey radar monitoring.

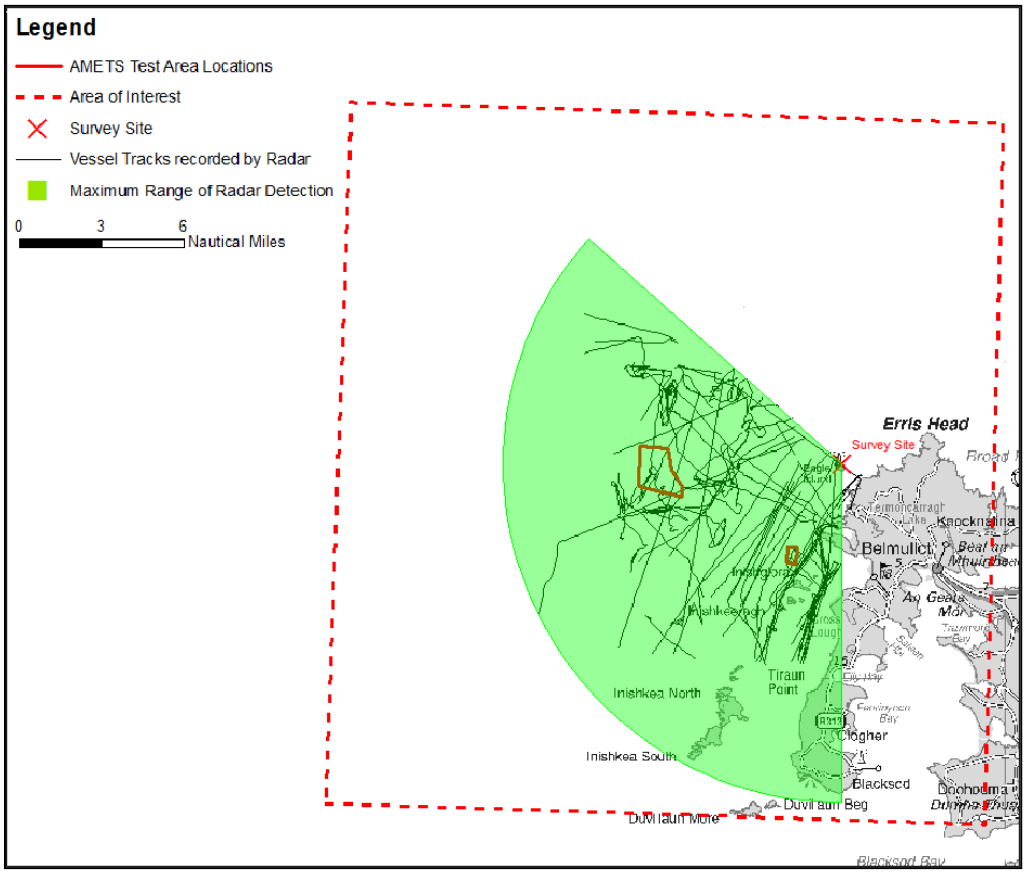

Figure 35 Approximate range of radar detection during Summer Survey

There is one other disadvantage in relation to radar monitoring. In some instances the total vessel track showing the route taken by a vessel may not be recorded. Regularly the radar may not acquire a vessel immediately or may lose a vessel it is tracking due to different circumstances (environmental such as noise etc.) and as a result a track may appear without a start or finish point at the coast.

7.3.3 Visual Observations

Visual observations were undertaken on an hourly basis during day light hours if weather conditions permitted. Visual observations were used to supplement the information acquired by the shore-based radar monitoring system and to also validate the data recorded by the AIS and shore-based radar. There were no visual observations which were not also picked up by radar.

7.4 General Area Analysis

Both surveys were analysed separately as they represent different periods of the year (i.e. winter season and summer season). The radar and AIS tracks recorded passing within the Area of Interest surrounding AMETS during each period of surveying were analysed in terms of vessel type, daily numbers, shipping density and encounters. The following sections show the results of this analysis relative to the location of AMETS.

7.4.1 Vessel type

Figure 36 and Figure 37 present the vessel tracks passing within the Area of Interest over the two survey periods. Tracks are colour-coded based on the vessel type information identified from the radar and AIS data recorded. The vessel tracks were created by linking a succession of appropriate points recorded by the radar and AIS. Each track indicates the route taken by a vessel.

It is clear from looking at Figure 37 that there are a considerable number of vessels classified as cargo and 'other' travelling from E-W and W-E to the north of AMETS. These vessels were likely involved in the construction of a gas installation at the Corrib gas field and contribute to the increased number of cargo and other vessels identified during the Summer Survey period.

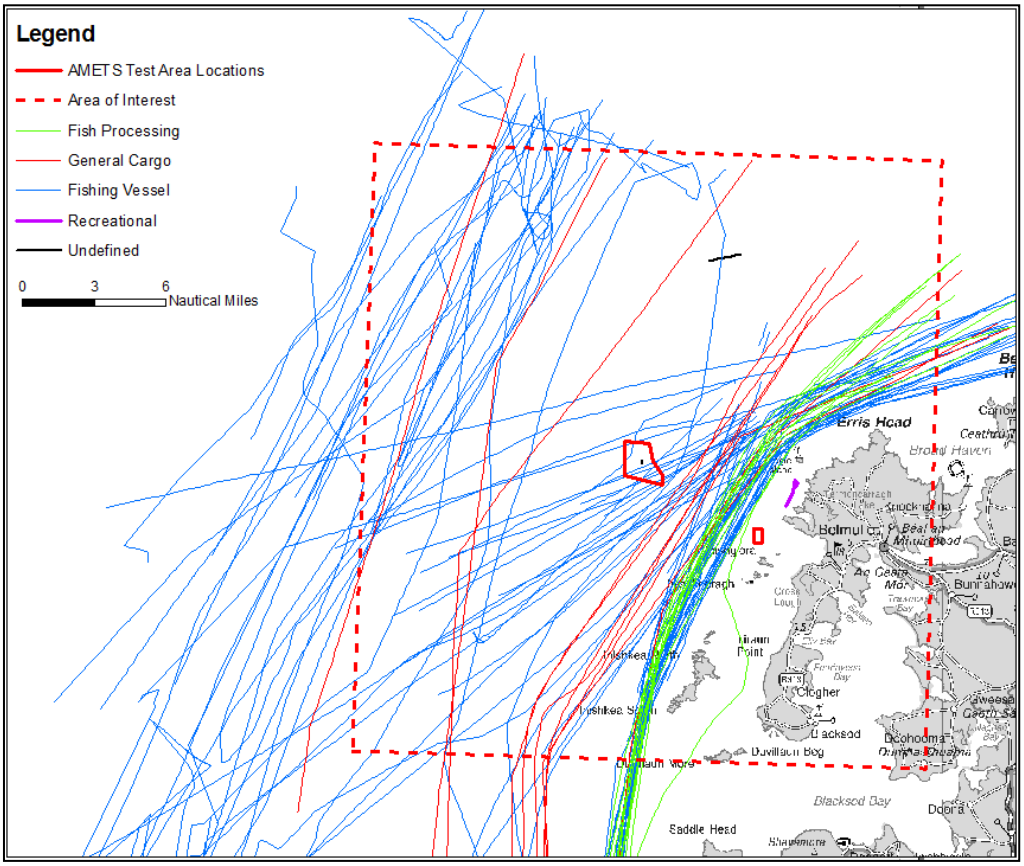

Figure 36 Winter Survey tracks colour-coded based on vessel type

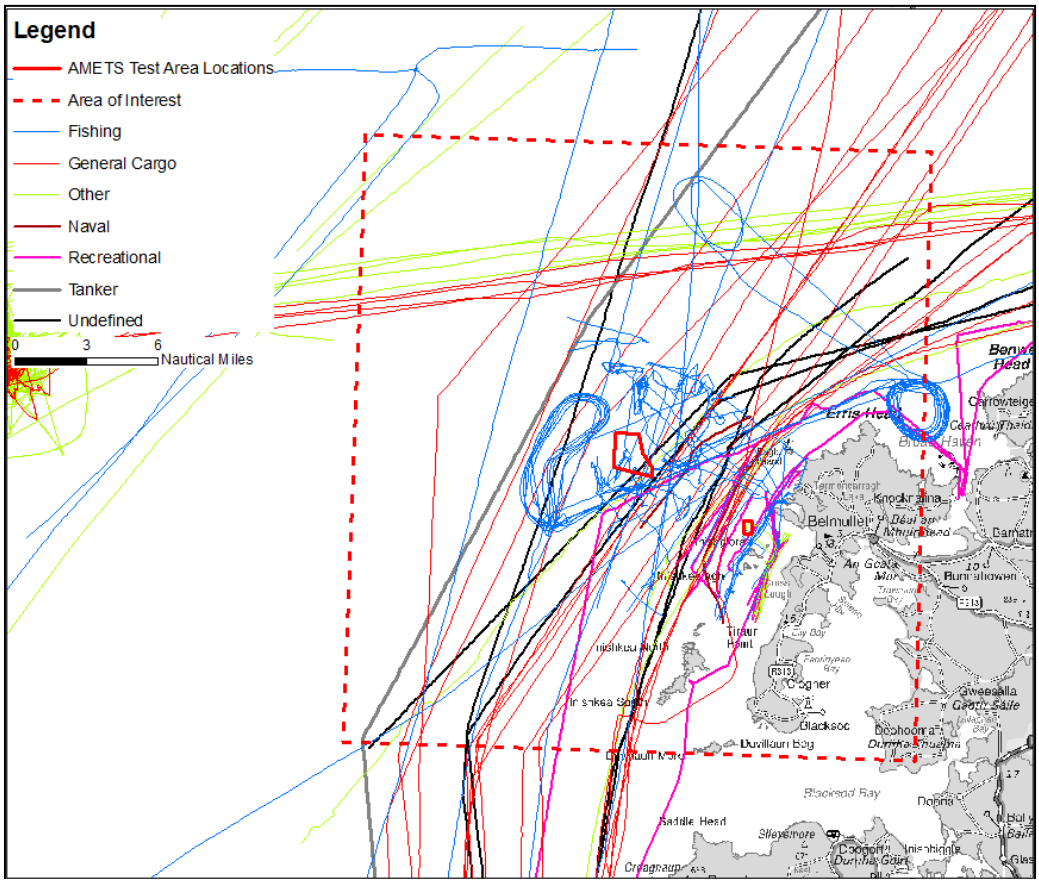

Figure 37 Summer Survey tracks colour-coded based on vessel type

Table 7.4.1 summarizes the number of tracks associated with each category of ship identified within the Area of Interest around the AMETS.

Number of Tracks per Category	Winter Survey	Summer Survey
Fishing	84	58
General Cargo	10	17
Recreational	1	15
Fish Processing	7	0
Naval	0	2
Tanker	0	1
Other	0	12
Undefined	3	4
Total	**105**	**109**

Table 7.4.1 Number of tracks per ship type during winter and Summer Survey

The breakdown of ship types passing within the Area of Interest, for both surveys, is shown in Figure 38 and Figure 39.

From the Winter Survey, it can be seen that the majority of the 105 tracks were made up by fishing vessels (80%). Cargo vessels (8%) and Fish Processing (8%) vessels are also prominent. Fish Processing vessels refer to a live fish carrier that operates in the area (transporting fish from fish farm to processing station). These

vessels do not carry out any fishing. 3% of the tracks established by the survey were undefined.

It is apparent from the Summer Survey that the majority of the 109 tracks comprised of fishing vessels (53%) and Cargo vessels (15%). 1% of the tracks established by the survey were undefined. Other ships accounted for 14% of tracks; this category is comprised of such vessels as tugboats and workboats.

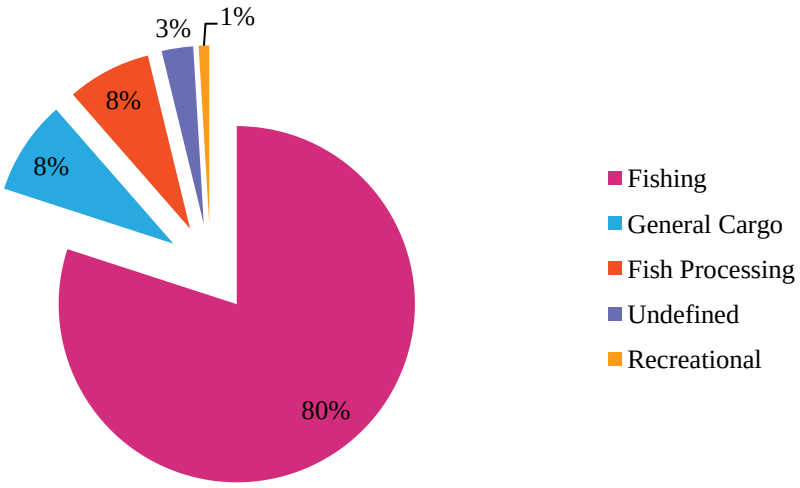

Figure 38 Vessel Types identified within Area of Interest during the Winter Survey

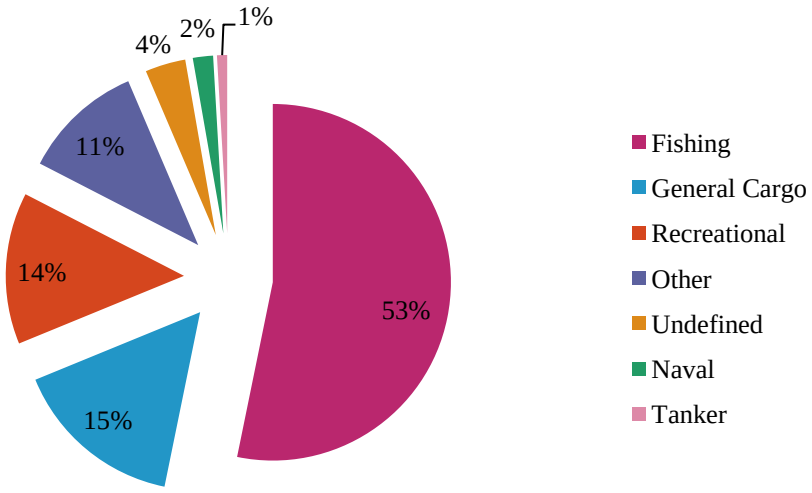

Figure 39 Vessel Types identified within Area of Interest during Summer Survey

7.4.2 Daily Traffic Levels

Figure 40 and Figure 41 present the number of tracks per day recorded within Area of Interest surrounding AMETS area during both surveys.

The average number of tracks per day passing within the Area of Interest during the period of the Winter Survey was 8.6 tracks and during the period of the Summer Survey was 7.1 tracks.

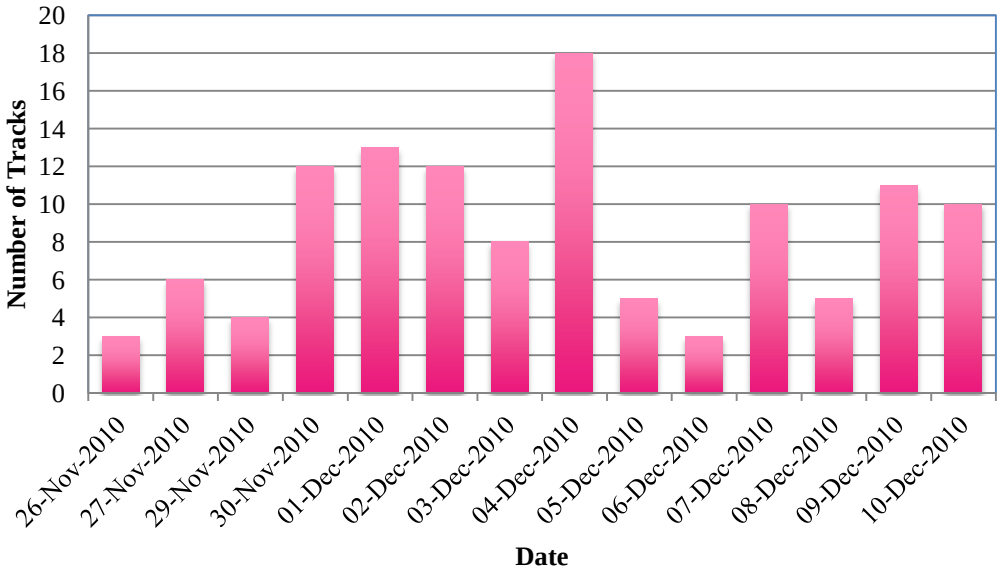

Figure 40 Winter Survey - tracks per day recorded within Area of Interest

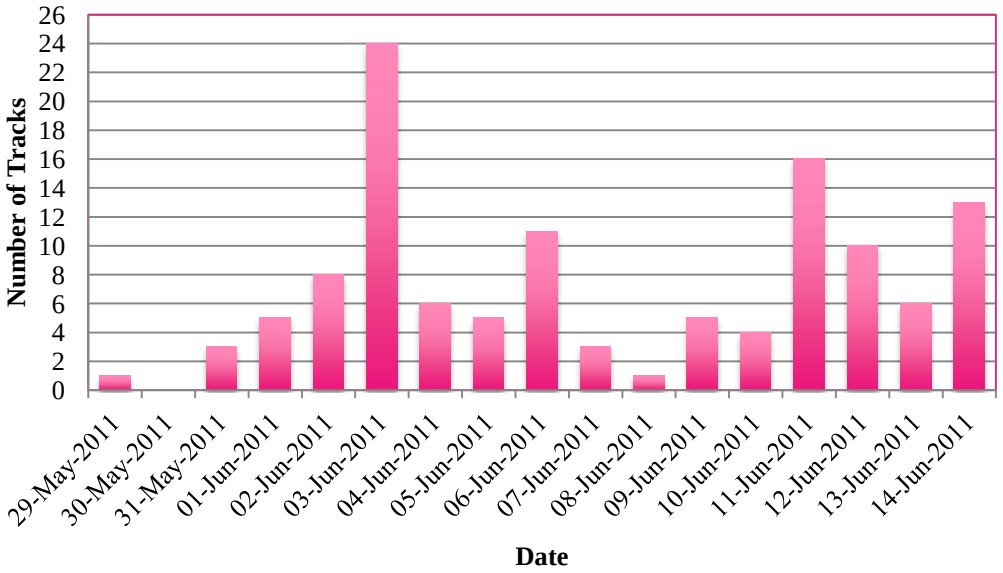

Figure 41 Summer Survey - tracks per day recorded within Area of Interest

	Winter Survey	Summer Survey
Busiest Day	4 December 2010	3 June 2011
No. of Unique Tracks	18	24
Quietest Day	26 November 2010 / 6 December 2010	30 May 2011
No. of Unique Tracks	3	0

Table 7.4.2 Summary of busiest and quietest days based on number of tracks per day for both winter and Summer Surveys

Figure 42 to Figure 44 show plots of the tracks recorded during the busiest and quietest days for the Winter Survey.

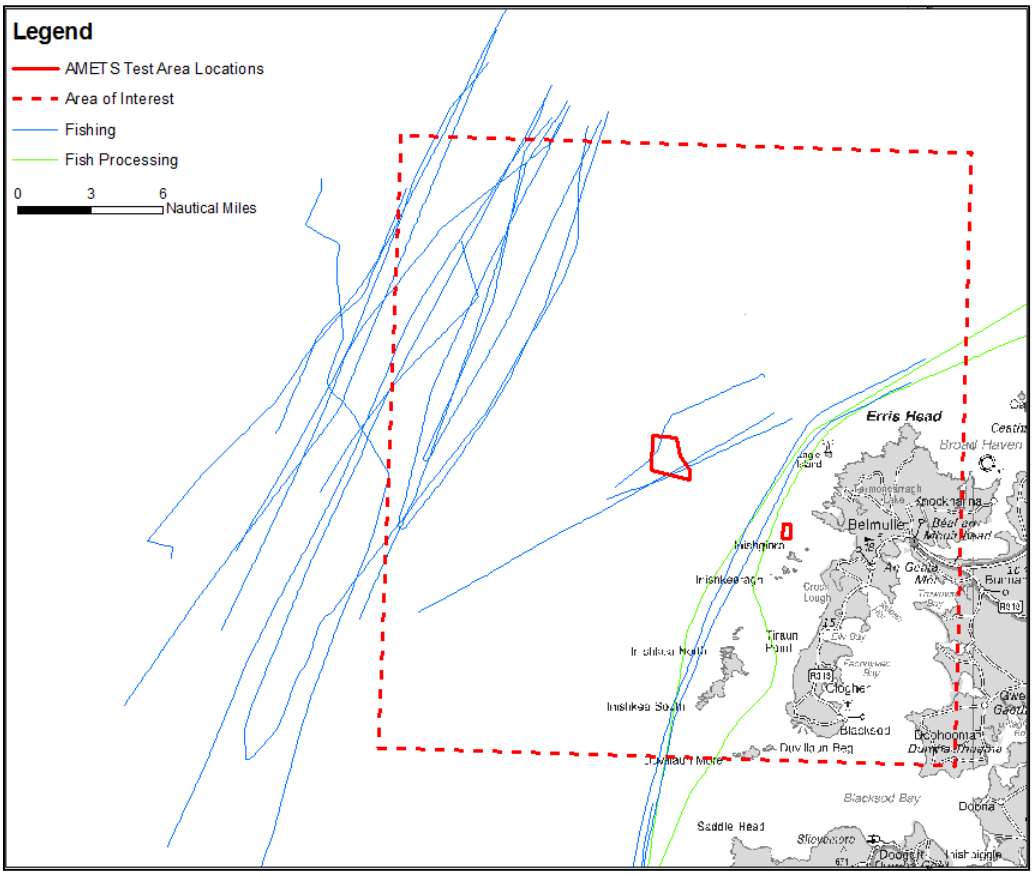

Figure 42 Winter Survey – vessel tracks on busiest day (4 December 2010)

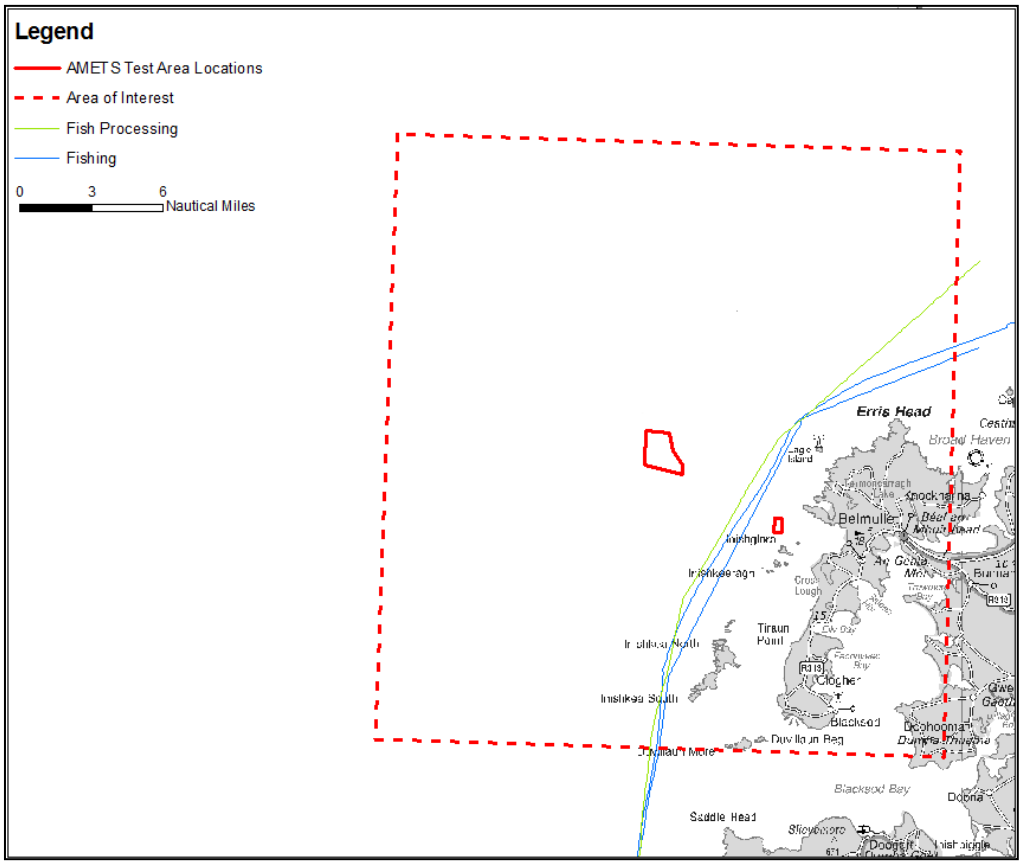

Figure 43 Winter Survey – vessel tracks on quietest day (26 November 2010, 3 tracks)

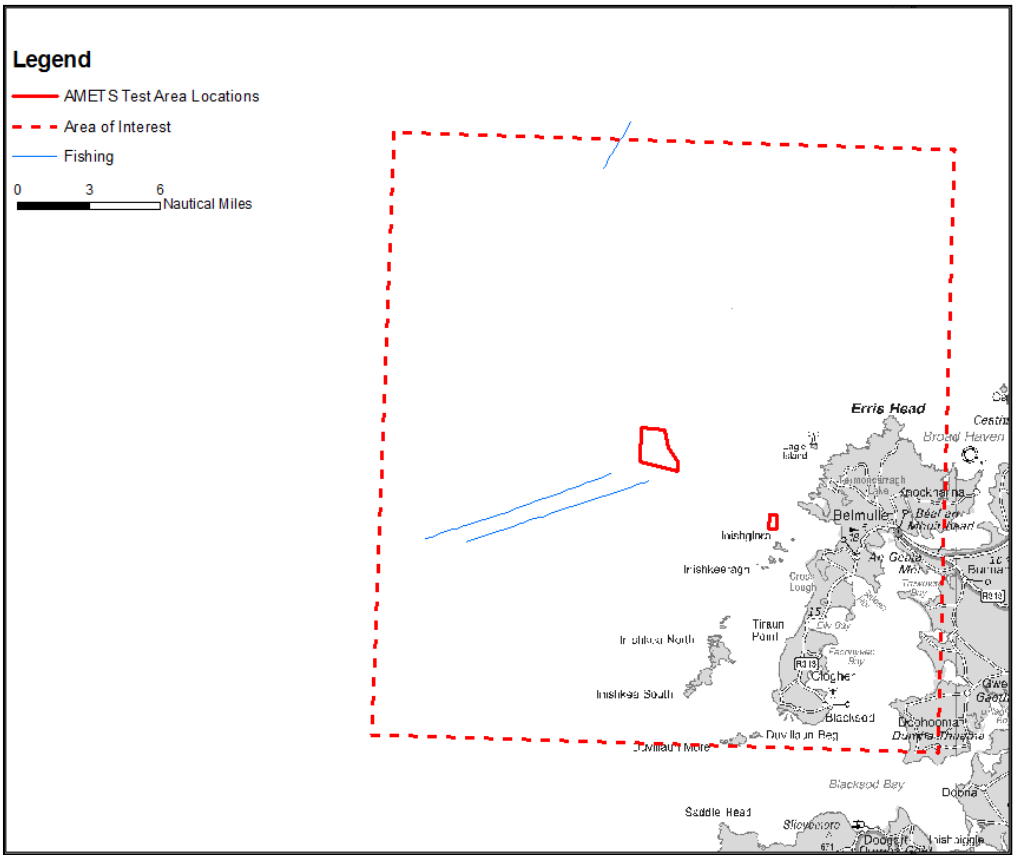

Figure 44 Winter Survey – vessel tracks on quietest day (6 December 2010, also 3 tracks)

Figure 45 shows a plot of the tracks recorded during the busiest day during the Summer Survey. The quietest day during the Summer Survey shows no tracks recorded.

The majority of vessels tracks on June 3rd were short tracks recorded by radar. This was as the dominant vessels on the day in question, were small fishing vessels, yachts and RIB boats of fishing vessels which travelled short distances. June 3rd proved to be the busiest day on record over the two survey periods. The fact that June 3rd was shortly after a stormy weather period must certainly have contributed to the increased activity.

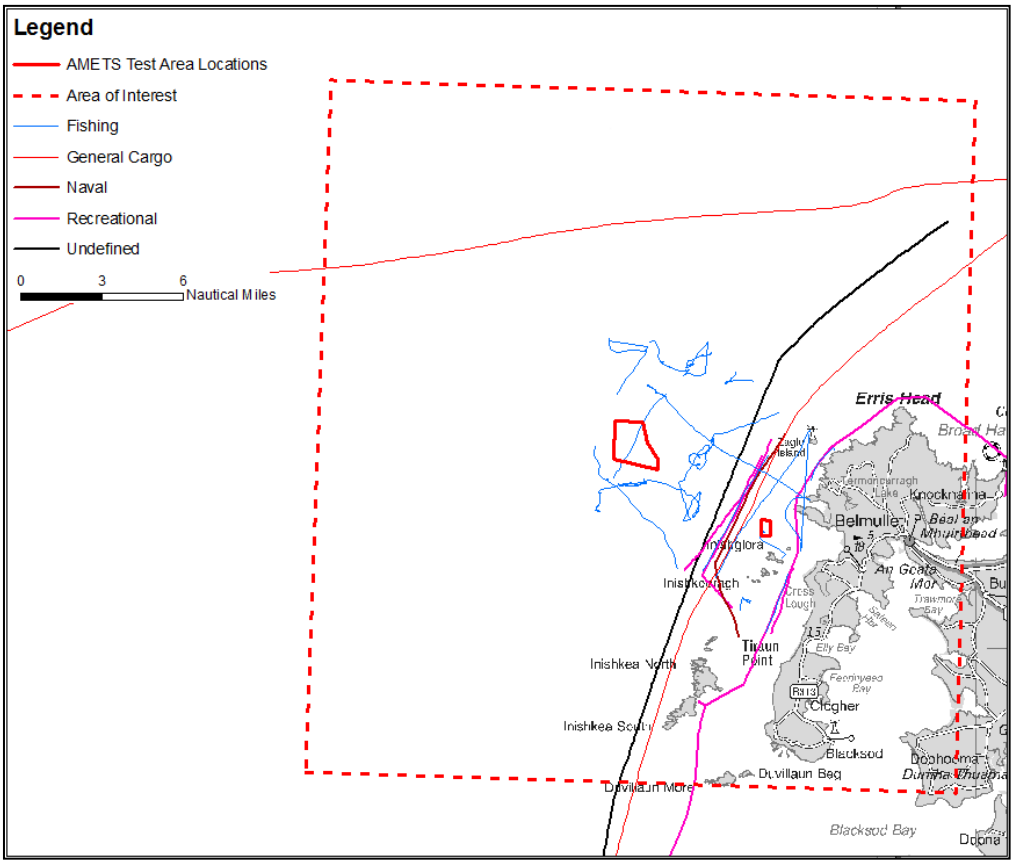

Figure 45 Summer Survey – vessel tracks on busiest day (3 June 2011)

7.4.3 Shipping Density

A grid of cells in the vicinity of the test site has been used to map the Vessel Track Density and Vessel Time Density from the survey data. The cell dimensions used were 1NM by 1NM.

7.4.3.1 Vessel Track Density

The Vessel Track Density relates to the number of tracks that entered each 1 NM square of grid. The Vessel Tracks Density plot for both the Winter and Summer Surveys are shown in Figure 46 and Figure 47.

During the Winter Survey, it can be seen that the highest Vessel Track Density area occurs in the inshore area along the coast, between the two proposed Test Areas, as the vessels travel around Erris head. The vessels continue down along the coast passing outside the islands off the coast of Mayo (Inishglora, Inishkeeragh, Inishkea North and Inishkea South).

The Vessel Track Density plot for the Summer Survey shows most of the activity during this survey period occurring in close proximity to the test site areas. This is partly due to the reduced radar range and the fact that the radar only detected vessels close to the test site areas and not throughout the whole Area of Interest. There higher activity to the north of the site can be attributed to vessels travelling to the Corrib gas field installation.

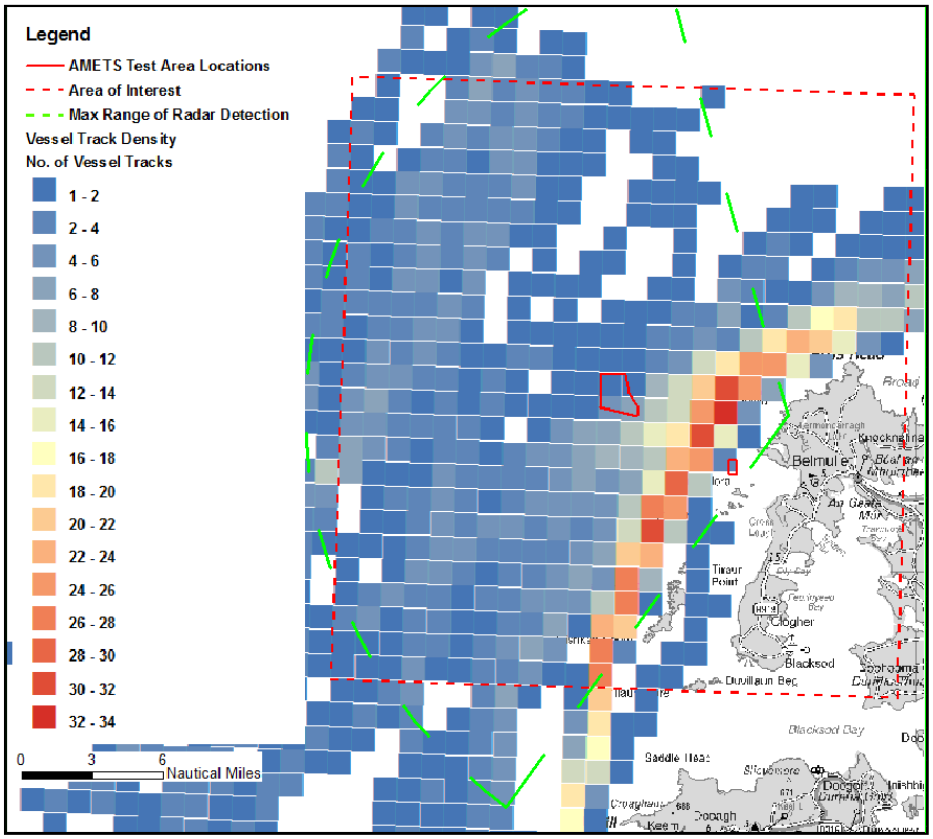

Figure 46 Vessel Track Density during the Winter Survey

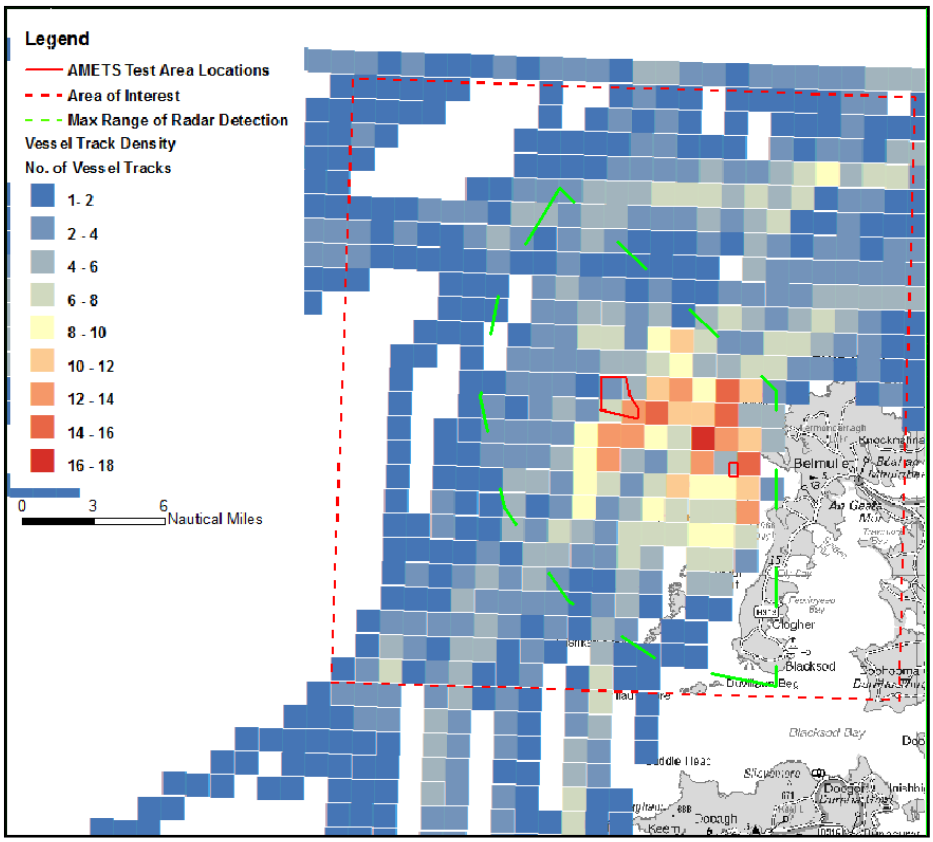

Figure 47 Vessel Track Density during the Summer Survey

7.4.3.2 Vessel Time Density

The vessel time density relates to the time a vessel track has spent within each 1 NM square of grid. The Vessel Time Density plot for both the Winter and Summer Surveys are shown in Figure 48 and Figure 49.

During the Winter Survey, it can be seen that the highest Vessel Time Density area occurs in the inshore area similar to where the highest Vessel Track Density was identified. A small pocket of increased time density activity can be seen to the NE of the test site at the boundary of the Area of Interest.

The Summer Survey vessel time density plot shows a large amount of activity in the vicinity of the test area locations. Vessels have spent substantial amounts of time in areas both north and south of the Test Area A. The fact that radar detection area was limited to the area close to the test site during the Summer Survey most certainly contributed to the high Vessel Time Density level close to both Test Areas.

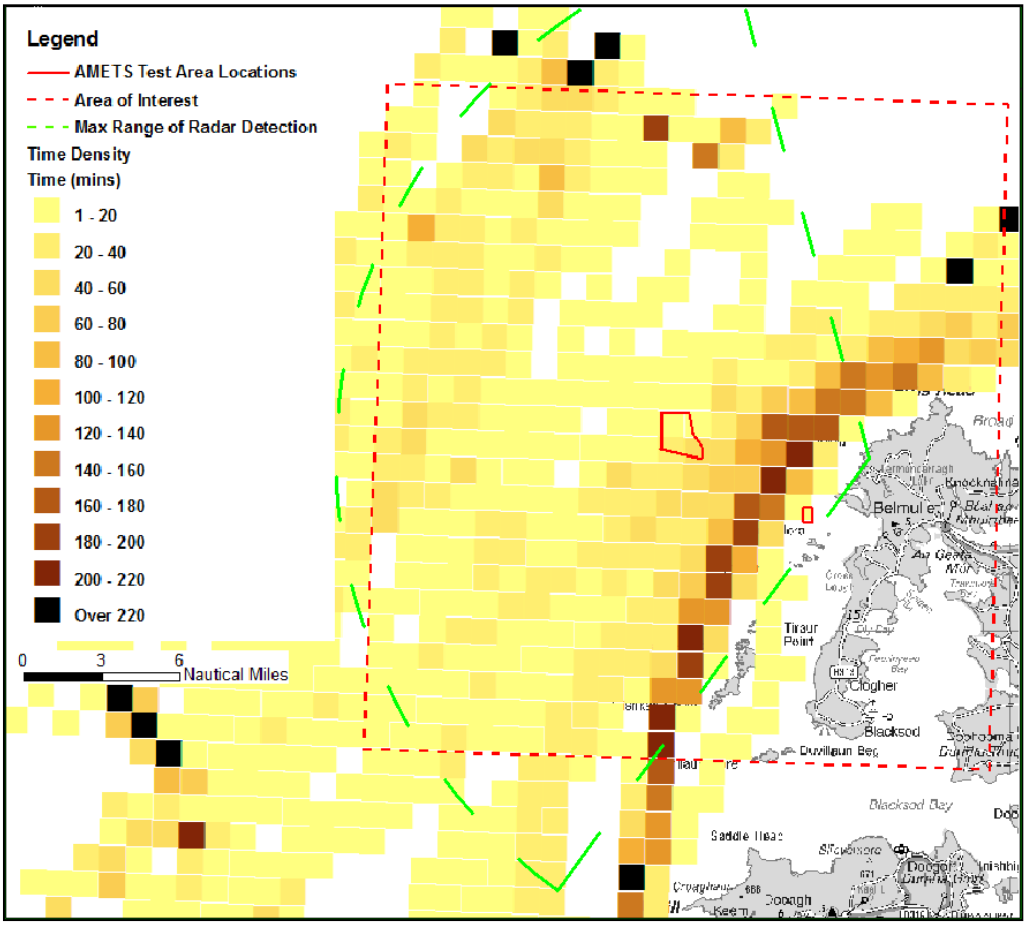

Figure 48 Vessel Time Density during Winter Survey

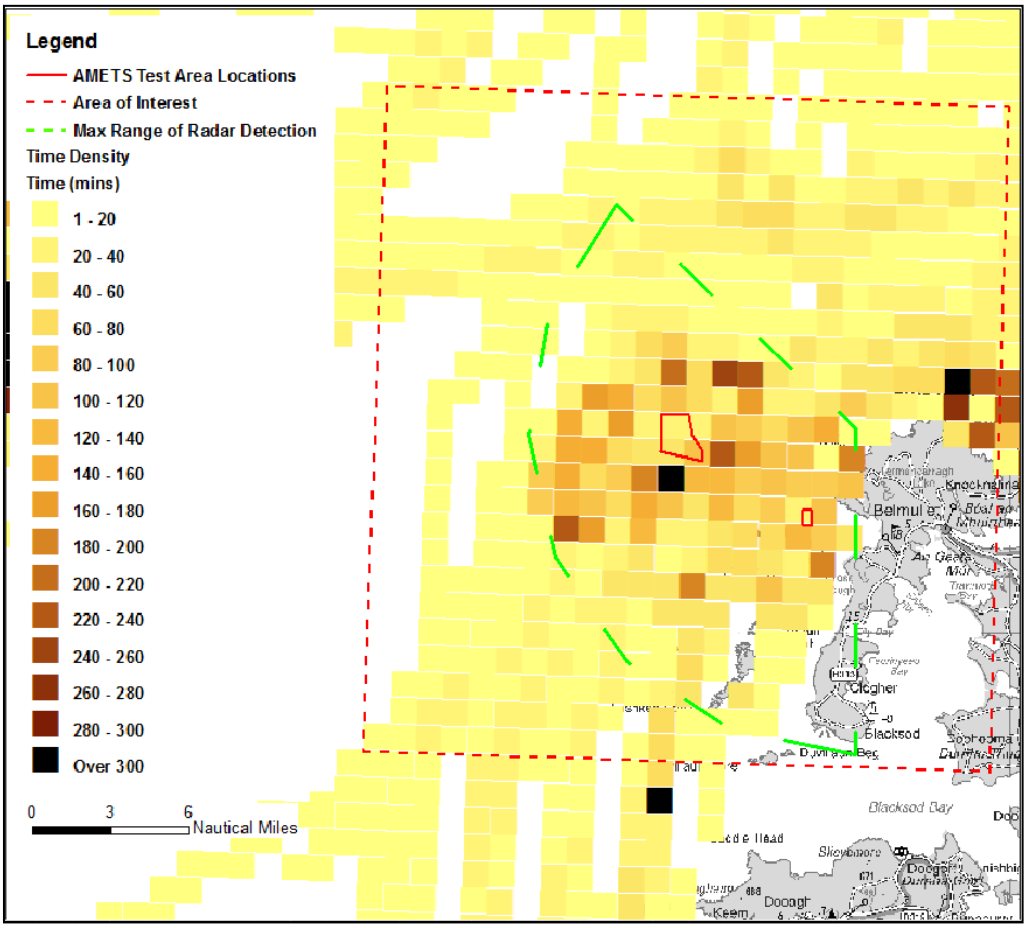

Figure 49 Vessel Time Density during Summer Survey

7.4.4 Encounters

The encounter tracks, tracks involved in an encounter, over the total of both survey periods within the Area of Interest surrounding AMETS are presented in Figure 50 and Figure 51, where an encounter has been defined as vessels passing within 1 NM of each other.

These figures provided help to illustrate where existing vessel encounters are highest relative to the AMETS, therefore identifying, if the location of the AMETS could potentially exacerbate congestion and hence increase the risk of encounters/collisions.

It can be seen from Figure 50 that there was a relatively small number of encounters identified during the Winter Survey. The majority of encounters were recorded to the east of Test Area A travelling in the inshore area along the coast. One encounter was identified to the west of the site.

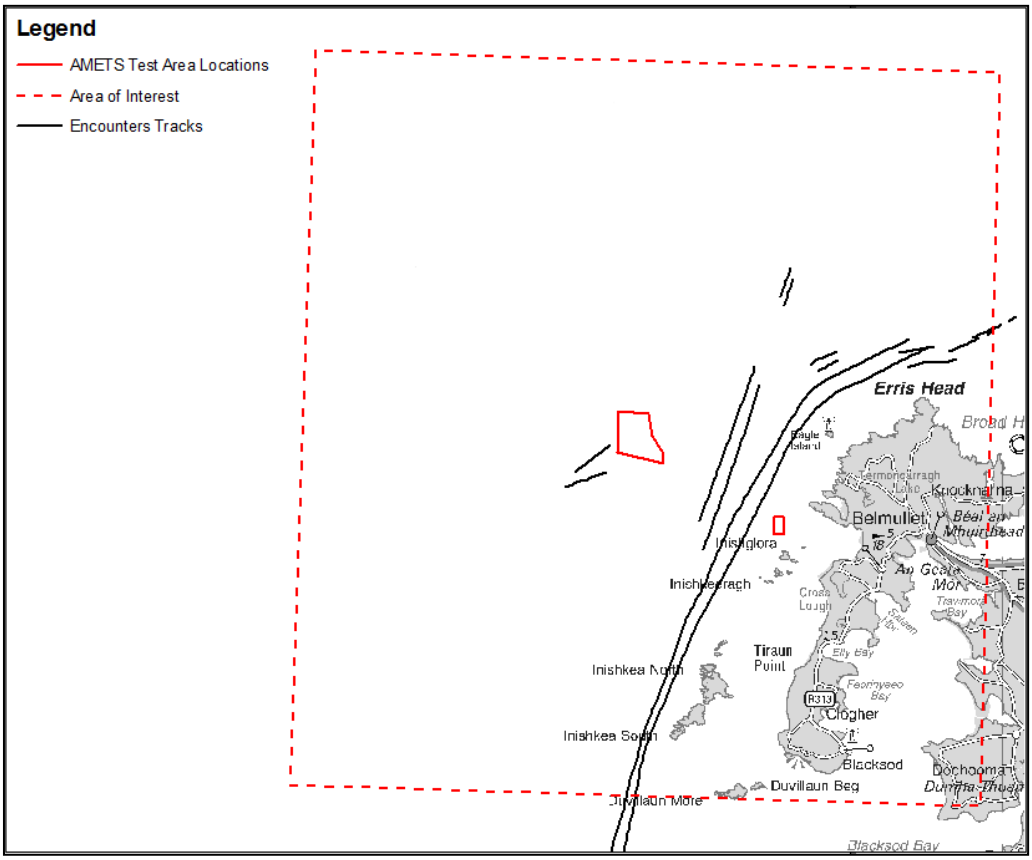

Figure 50 Distribution of Encounter Tracks recorded during the Winter Survey

It can be seen from Figure 51 that there was also a relatively small number of encounters identified during the Summer Survey. Three of the encounters occurred close to the AMETS as seen in Figure 52.

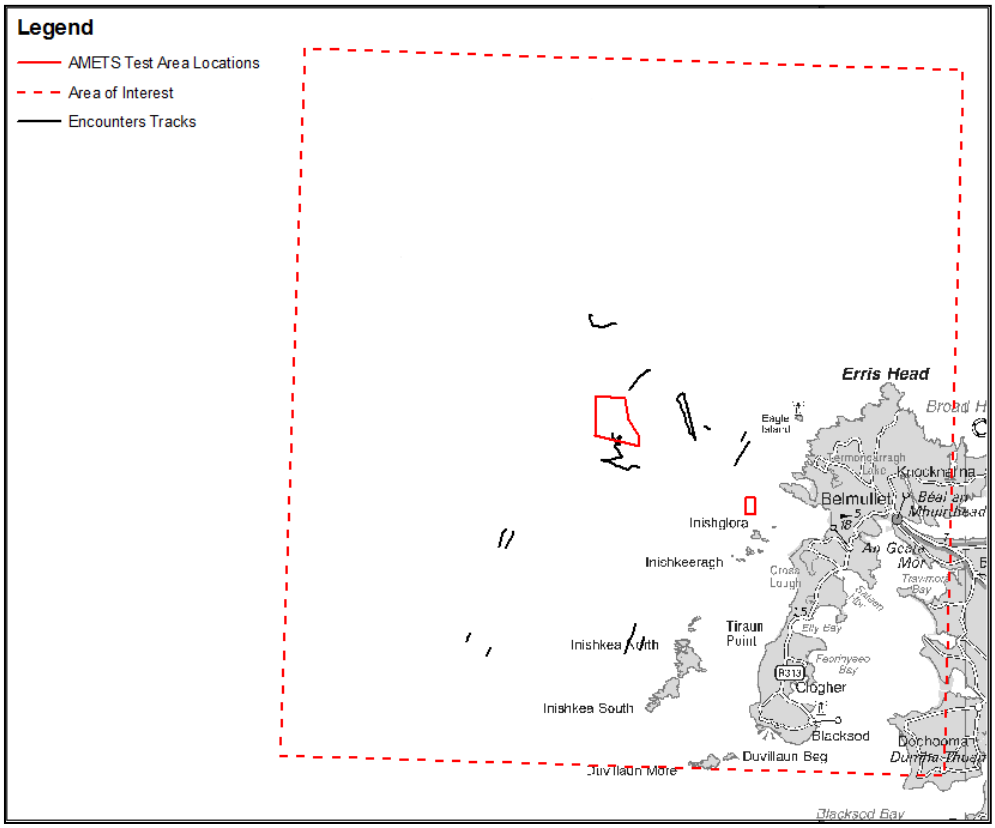

Figure 51 Distribution of Encounter Tracks recorded during the Summer Survey

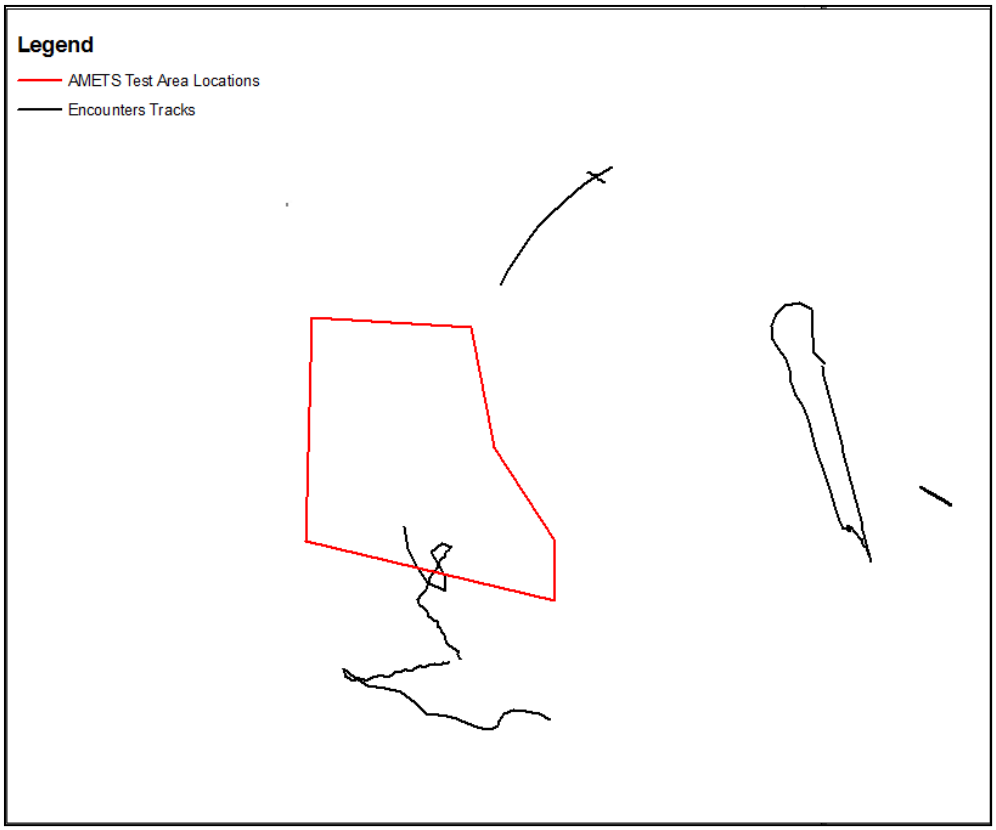

Figure 52 Encounter Tracks close to the AMETS Test Area A recorded during the Summer Survey

It is clear from the figures above that the density of encounters in the vicinity of the AMETS was low during the both the winter and Summer Survey periods.

There were no encounters noted near the inner Test Area B during the two survey periods.

7.5 Site Specific Analysis

The vessel activity travelling through each of the two AMETS test areas is assessed within the following section.

7.5.1 Outer Test Site Area A

A detailed plot of the survey tracks recorded during both surveys within the AMETS Test Area A is presented in Figure 53 and Figure 54.

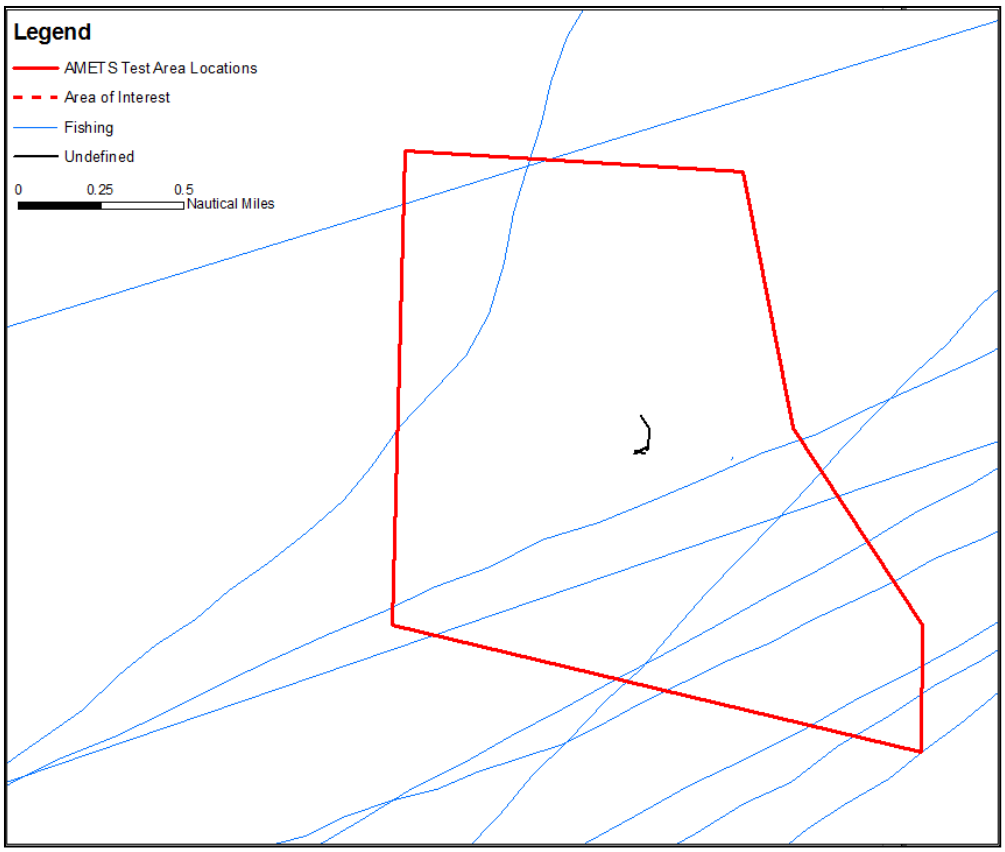

Figure 53 Winter Survey - detailed chart of tracks by vessel type passing within AMETS Test Area A.

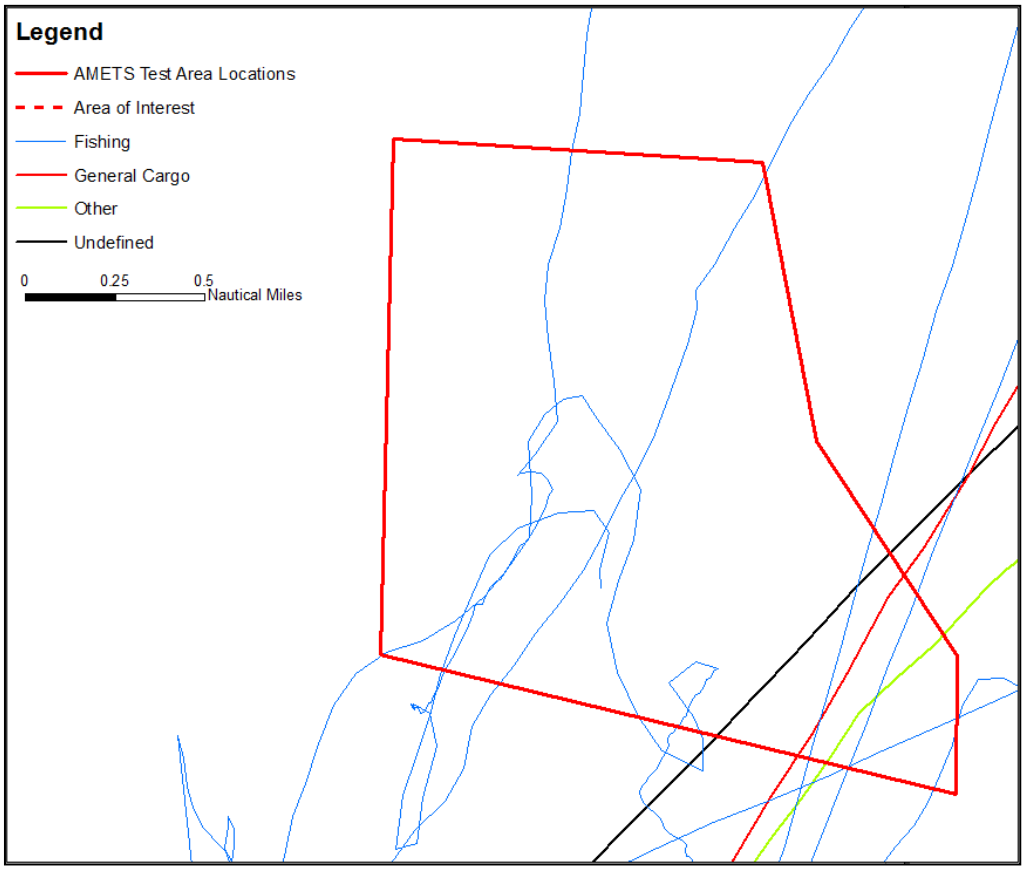

Figure 54 Summer Survey - detailed chart of tracks by vessel type passing within AMETS Test Area A.

A total of 12 tracks were identified passing within the AMETS Test Area A during the Winter Survey, an average of nearly one vessel every day. On four days no vessel passes within the AMETS area.

A total of 10 tracks were identified passing within the AMETS Test Area A during the Summer Survey, an average of one vessel every two days. It was seen that on 10 days during the Summer Survey no vessel travelled within the site.

The daily distribution of vessels entering Test Area A for both survey periods is presented in Figure 55 and Figure 56 below.

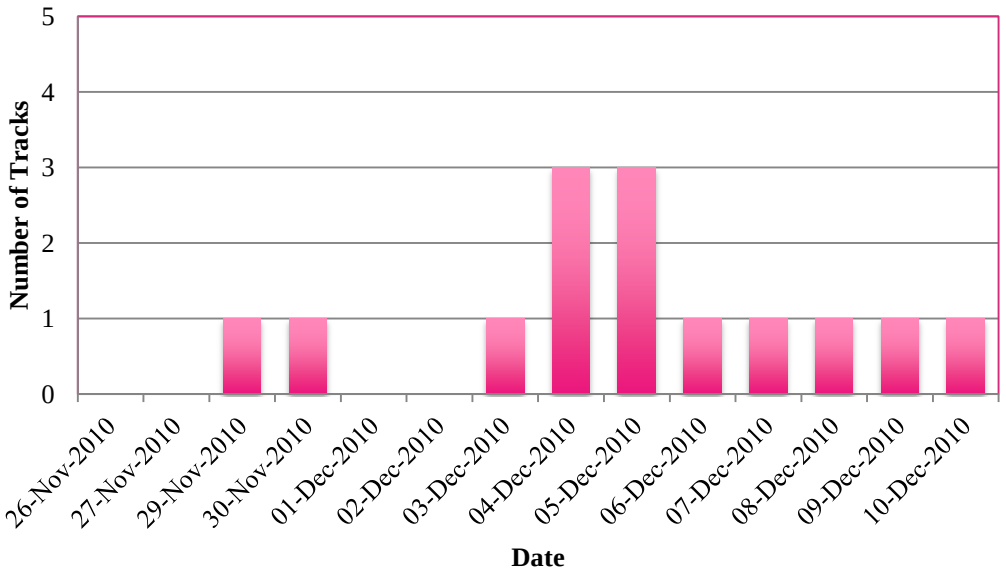

Figure 55 Winter Survey - tracks per day passing within AMETS Test Area A

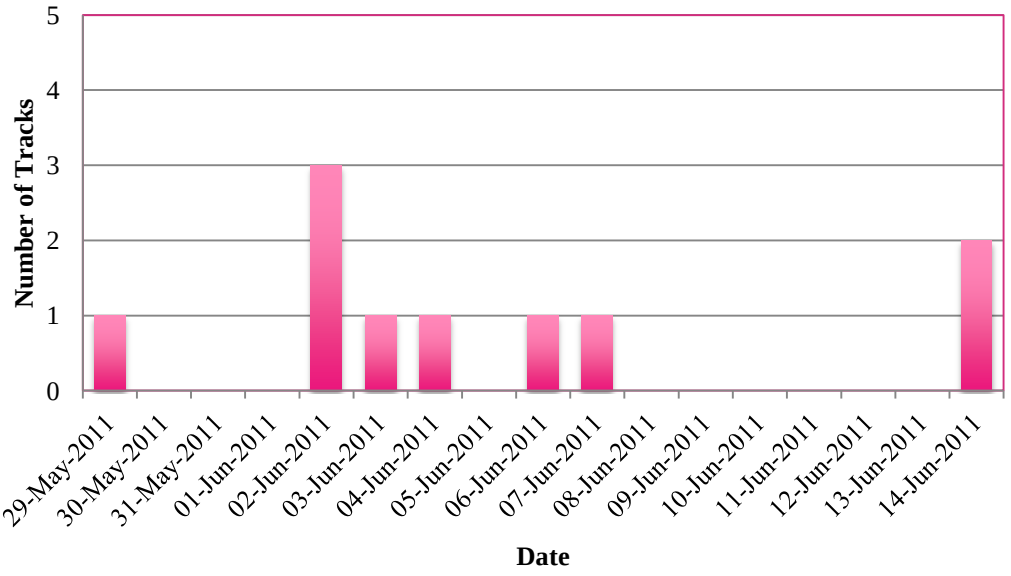

Figure 56 Summer Survey - tracks per day passing within AMETS Test Area A

In the Winter Survey, 11 out of the 12 vessels passing within the Test Area A were fishing vessels. The one remaining track was undefined.

The majority of tracks passing within the Test Area A were again fishing vessels (7) during the Summer Survey (See Routing and Vessel Activity 7.6.1). The remaining three vessels passing through the Test Area A were general cargo (1), other (1) and undefined (1).

7.5.2 Inner Test Site Area B

In carrying out the specific analysis of Test Area B it has been established that little vessel navigation activity occurs within the boundary of this area. During the Winter Survey no vessels were identified travelling within the site. Meanwhile Figure 57 shows the limited vessel activity that occurred during the Summer Survey.

Figure 57 Summer Survey - detailed chart of tracks by vessel type passing within AMETS Area B

A total of only 3 tracks were identified passing within the AMETS Test Area B during the Summer Survey. The tracks included fishing vessel (1), recreational (1) and other (1). For further information on vessel activity see Routing and Vessel Activity 7.6.

The daily distribution of vessels entering Test Area B is presented in Figure 58.

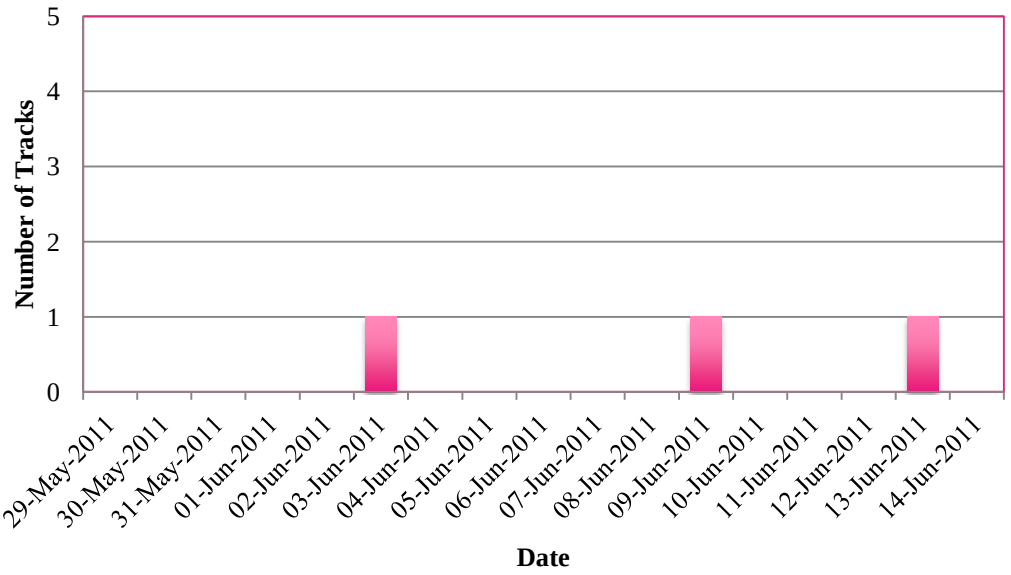

Figure 58 Summer Survey - tracks per day passing within AMETS Area B

7.6 Routing and Vessel Activity

7.6.1 Fishing Vessels

7.6.1.1 Fishing Routes

A moderate level of fishing vessels were identified passing within the Area of Interest surrounding AMETS. Plots of the tracks of fishing vessels recorded by radar and AIS over both surveys are presented in Figure 59 and Figure 61.

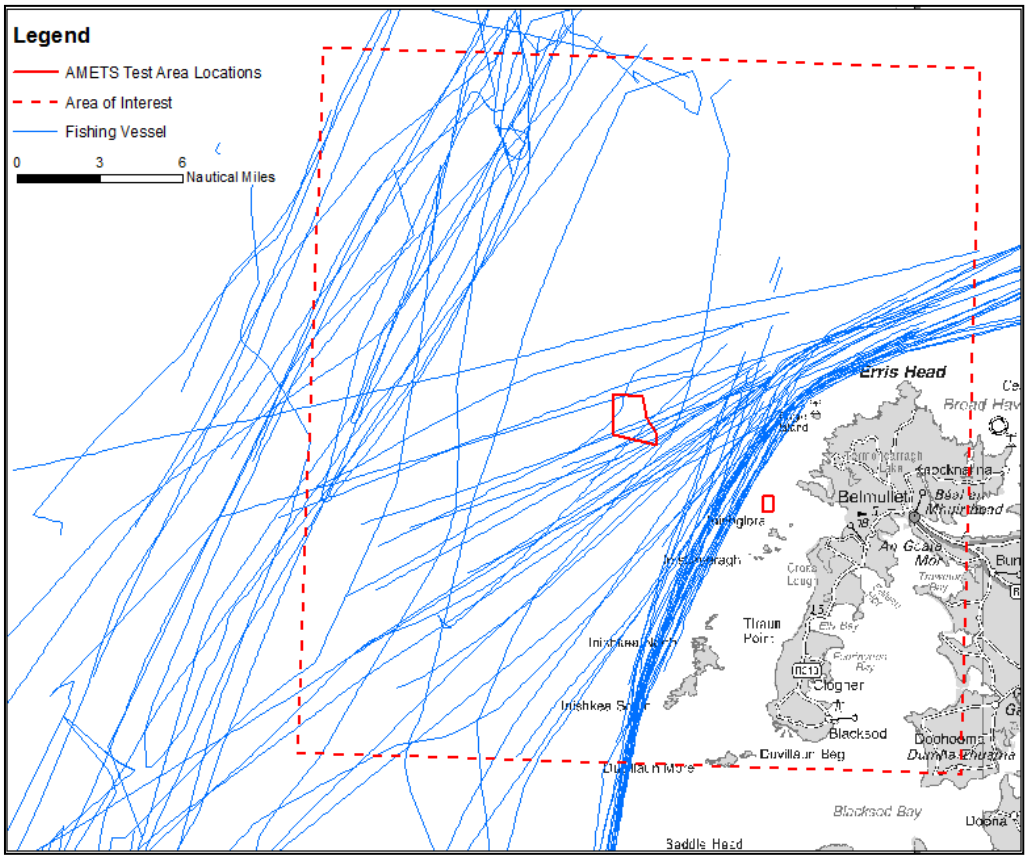

Figure 59 Winter Survey – fishing vessel tracks from radar & AIS data

During the Winter Survey 84 fishing vessel tracks were identified. Upon visual inspection of Figure 59, the following points can be noted:

- A number of fishing vessels have travelled through and in close proximity to the location of the AMETS test areas;
- A sailing route in the North-South direction is present between the two test areas along the coast of the Belmullet peninsula. Vessels along this route steer in front of Eagle Island from a S-N route to a W-E route and vice versa;
- Vessels to and from (presumably) Killybegs sail along a well identified common route between Eagle Island and Killybegs. Tracks spread west of Killybegs and represents fishing vessels sailing to/from fishing grounds;
- Tracks travelling in the SW-NE direction west of the proposed Test Area A may indicate vessels fishing within the previously noted offshore fishing grounds;
- The majority of tracks within the Area of Interest are relatively straight tracks and would indicate vessels travelling directly to fishing grounds in the deeper waters. Vessels travelling to the fishing grounds would usually not fish when in transit to the fishing grounds;
- Figure 60 shows all tracks but one within the outer Test Area A to be relatively straight indicating vessels navigating through the area en route to deeper waters. The one track which has turned within the site may have been trawling;
- There is no fishing vessel activity within Test Area B.

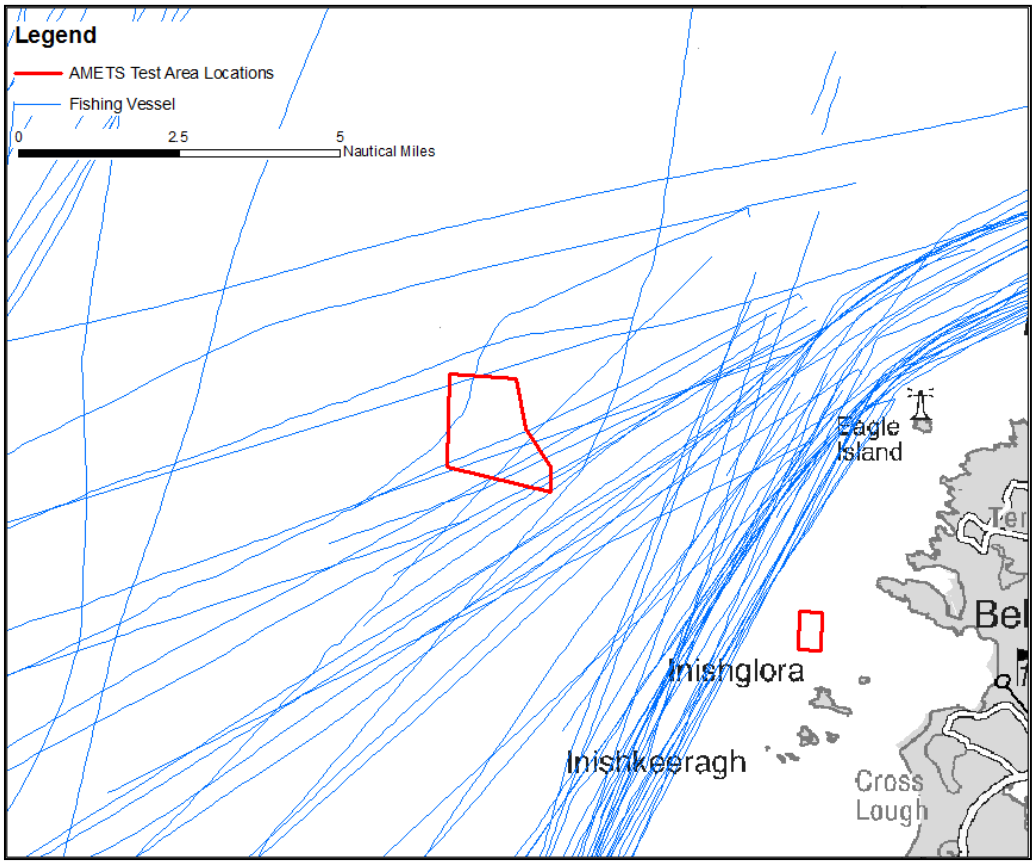

Figure 60 Winter Survey – fishing vessel tracks in close proximity to AMETS

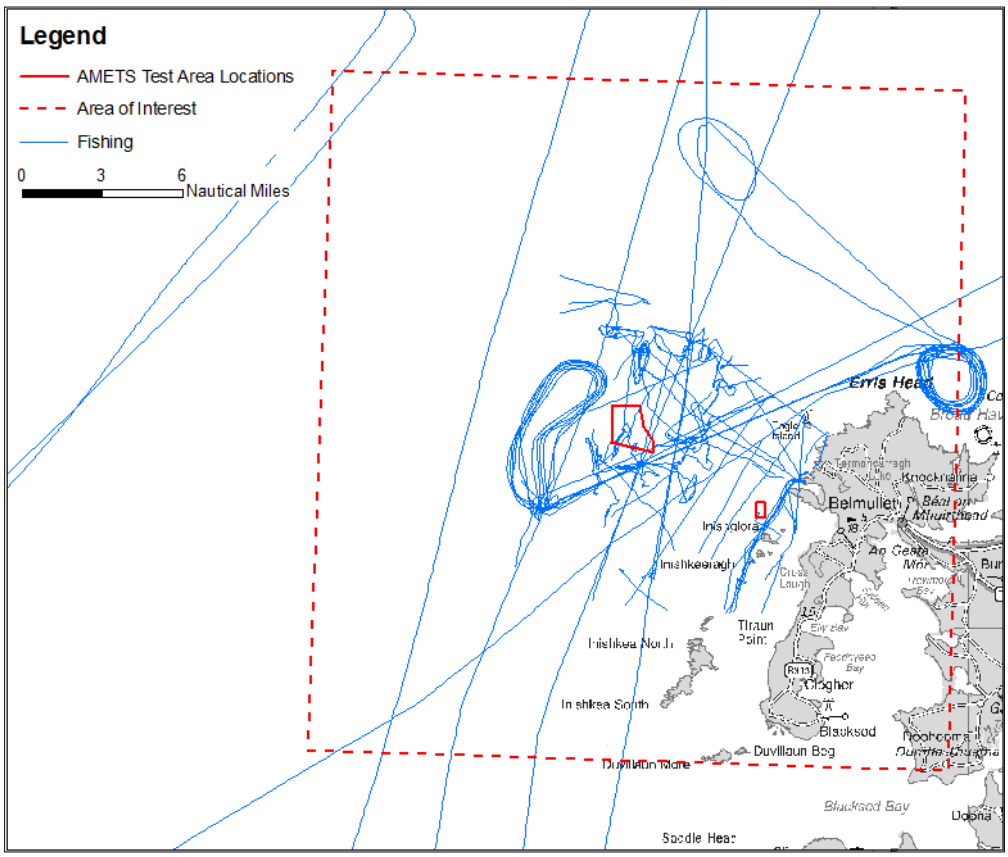

Figure 61 Summer Survey – fishing vessel tracks from radar & AIS data

The Summer Survey shows reduced number of fishing tracks in the area with only 58 fishing vessel tracks identified during the period. It is quite clear from looking at Figure 61 that there are less tracks recorded travelling through the site on the way to deeper fishing grounds. A large amount of the activity displayed in the Summer Survey is focused in close proximity to the boundary of the AMETS.

Upon visual inspection of Figure 62, the following points can be noted:

- Tracks are more confused and less distinct tracks are identifiable in the N-S direction. This reflects the reduced number of straight tracks travelling through the site and indicates vessels turning, possibly while in the process of fishing;
- A track (with the shape of a squeezed oval) is present west of the proposed Test Area A. This likely belongs to a fishing vessel engaged in fishing (possibly trawling) operations;
- A number of twisted tracks are present around and within the proposed Test Area A as shown in Figure 61 . These likely belong to vessels engaged in fishing (potting) operations.
- There was a single vessel travelling within Test Area B and its twisted path may indicate it was potting along the rocks.

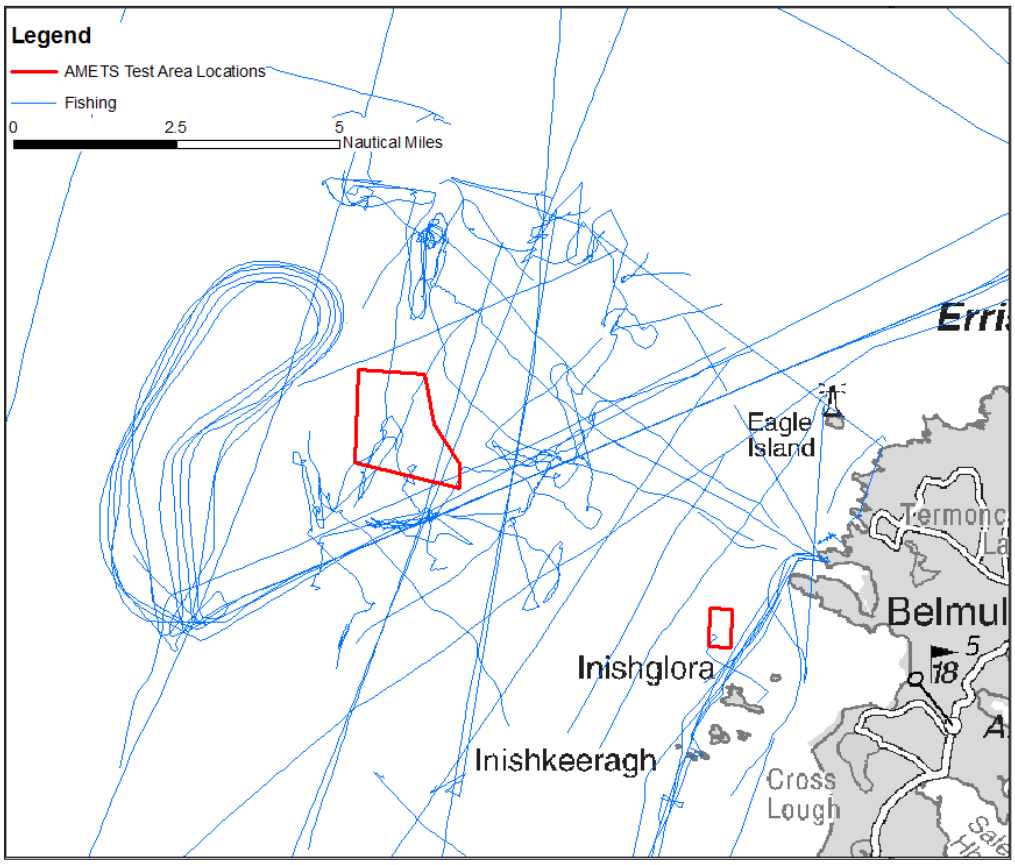

Figure 62 Summer Survey – fishing vessel tracks in close proximity to boundary of AMETS

7.6.2 General Cargo Vessels

7.6.2.1 General Cargo Routes

There was limited general cargo vessel activity passing within Area of Interest surrounding the AMETS location. Plots of the recreational vessel tracks recorded by radar and AIS over both surveys are presented in Figure 63 and Figure 64.

The cargo vessels can be seen travelling in the N-S or oppositely in the S-N direction. The bulk of the general cargo vessels identified during the Winter Survey kept to the inshore area and travelled between the two AMETS test area locations. Only three out of the ten tracks established travelled in the deeper waters west of the Test Area A. The route taken by these vessels was a considerable distance away from the two test areas.

The tracks for the Summer Survey in relation to general cargo vessels displayed much the same routes N-S and S-N. The inshore route was again dominant with only a small number of vessels taking the offshore route. There were a number of tracks that travelled E-W north of the AMETS which are probably vessels that were involved in the construction of the Corrib gas installation as mentioned earlier.

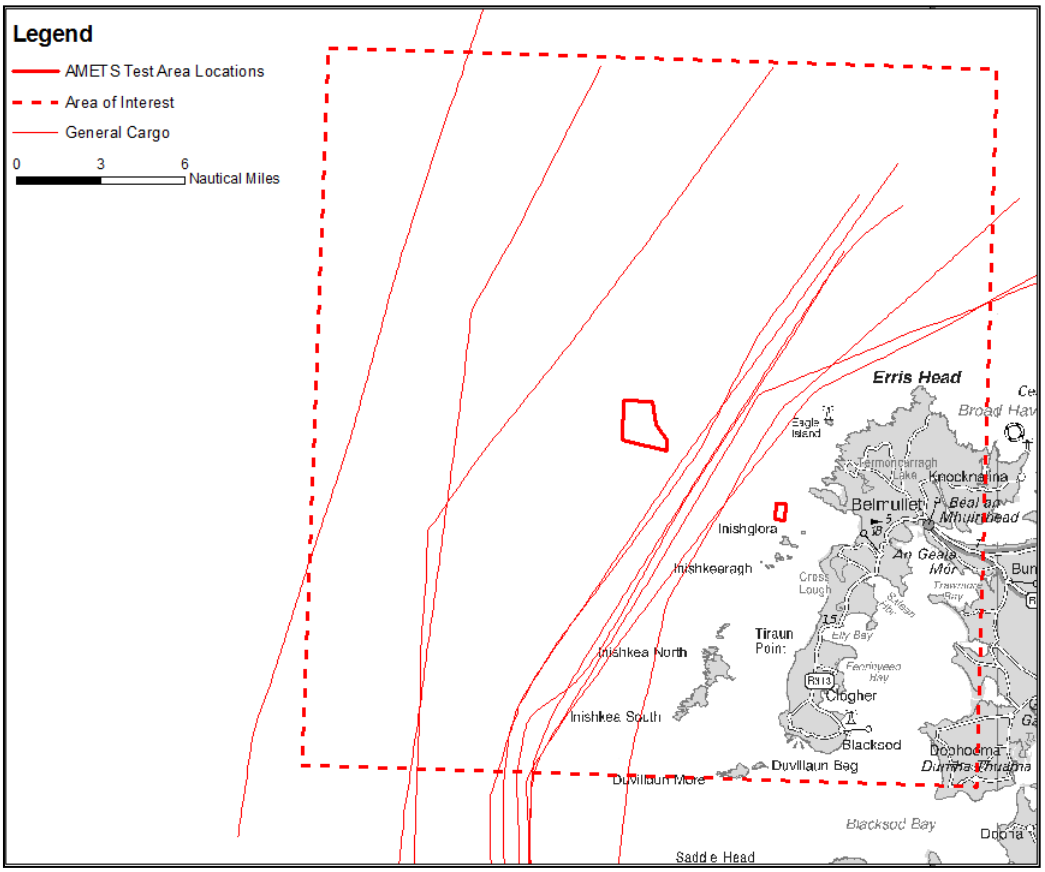

Figure 63 Winter Survey – general cargo vessel from radar and AIS data

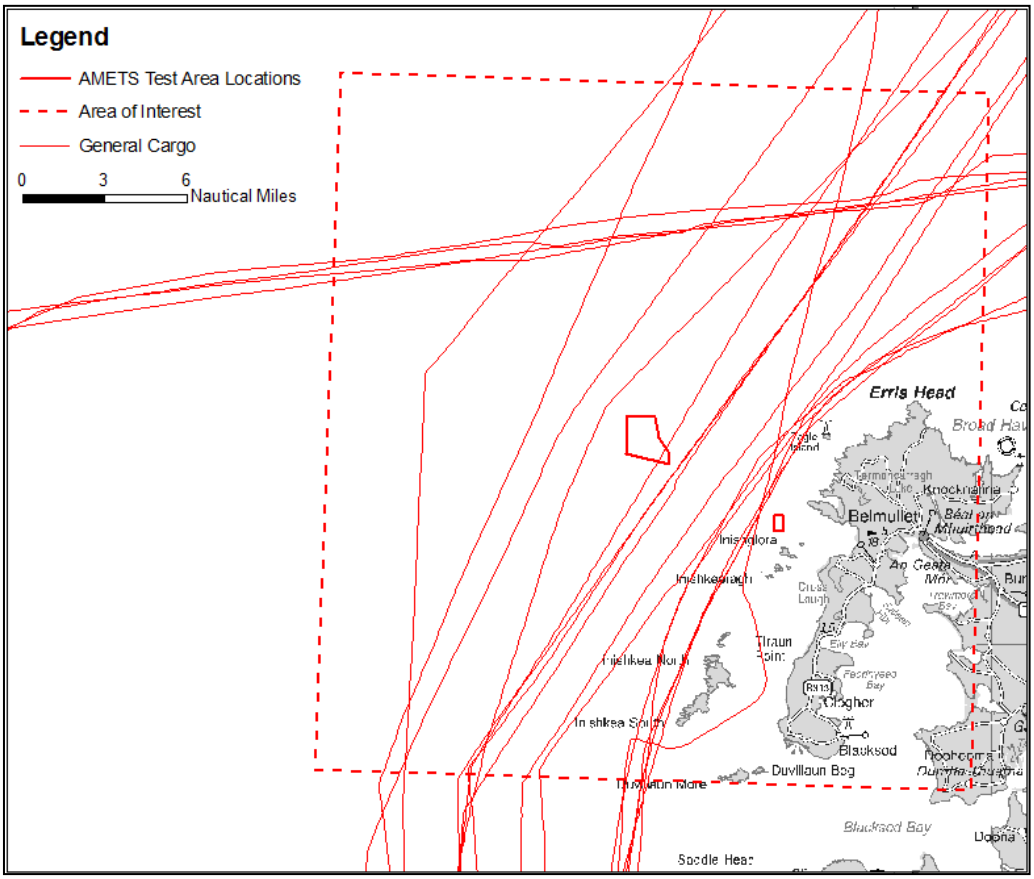

Figure 64 Summer Survey – general cargo vessel from radar and AIS data

7.6.3 Recreational Vessels

This section reviews recreational vessel activity for the proposed AMETS based on information from the radar and AIS survey data. It is important to note that carriage of AIS is not mandatory for recreational vessels, although some (probably larger) vessels carry it voluntarily. The recreational vessels not carrying AIS and travelling in the vicinity of AMETS were recorded during both survey periods by radar and visually by personnel manning survey equipment at the survey site.

7.6.3.1 Recreational Routes

Limited recreational vessel activity was identified passing within the Area of Interest around the AMETS location. Plots of the recreational vessel tracks recorded by radar and AIS over both surveys are presented in Figure 65 and Figure 66.

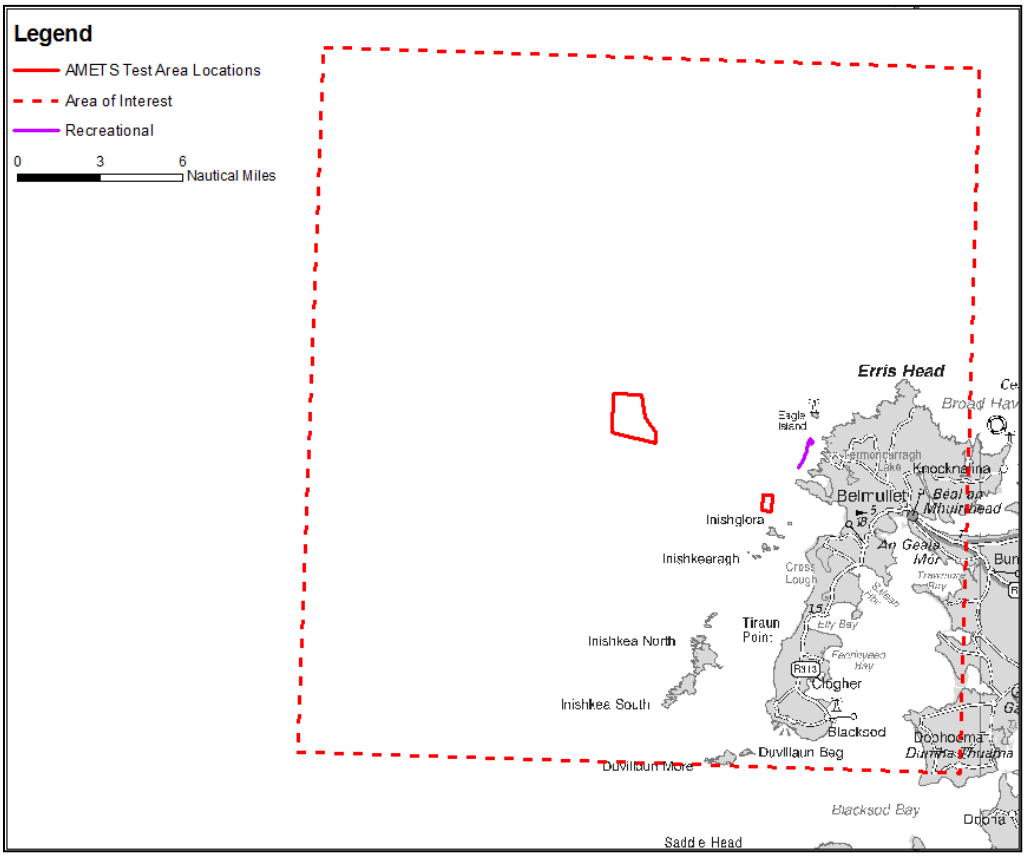

Figure 65 Winter Survey – recreational vessel tracks from radar & AIS data

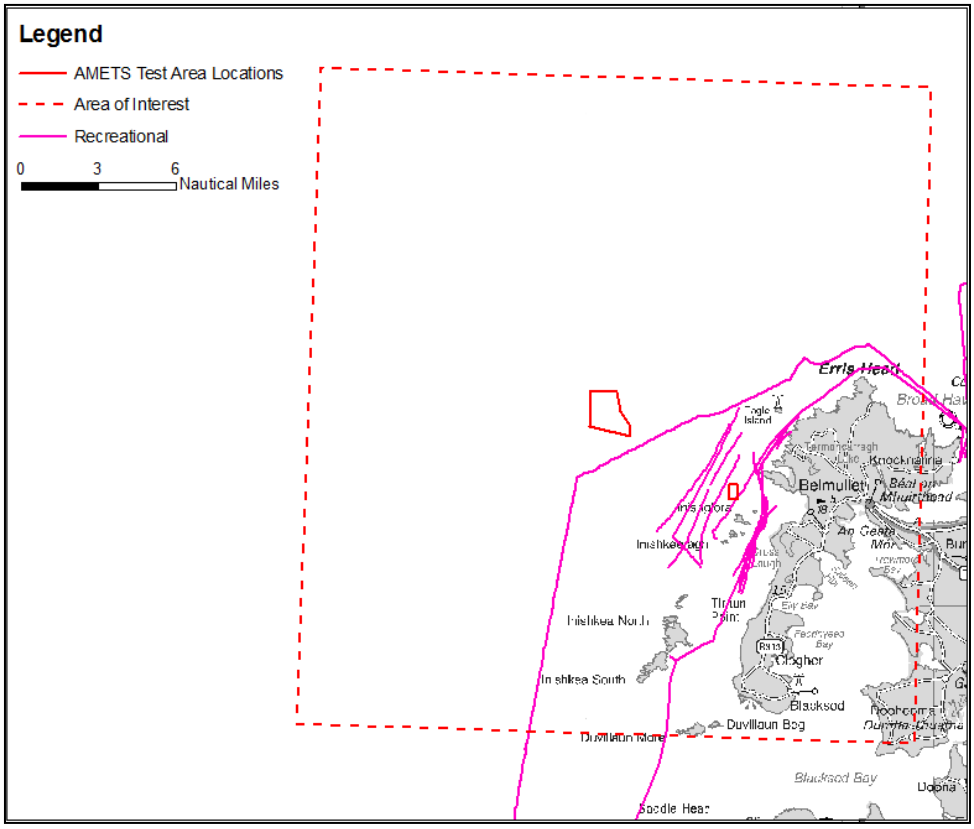

Figure 66 Summer Survey – recreational vessel tracks from radar & AIS data

The Winter Survey shows particularly limited activity with only one recreational vessel track identified over the whole survey period.

The Summer Survey shows an increased number of recreational vessels during the period of summer when the data was recorded. 15 recreational tracks were identified which comprised of such vessels as yachts, sailing boats and RIBs. It can be seen that the vast majority of recreational vessels use the inshore area thus the routes taken by the vessels are a considerable distance from where the Test Area A is located. The recreational vessels travel close to the location of Test Area B. It can be seen that the vessels currently travel inside and outside of the site, following the line of the coast.

7.7 Additional AIS Data

Additional AIS data was received from the Irish Coastguard. The AIS data included data recorded for both the full months of January 2010 and July 2010. AIS tracks were created as previous by linking appropriate points to form routes taken by each vessel. Figure 67 and Figure 68 show all tracks identified during both months colour-coded based on vessel type.

It is clear from Figure 67, which includes January 2010 AIS tracks, that a number of the conclusions drawn from the Winter Survey data have been reaffirmed.

- Fishing vessel tracks again dominated during the January period with a number travelling close to and through the site. The straight nature of the fishing vessel tracks validates that fishing vessels are travelling through the area opposed to actually fishing in the area.
- Cargo tracks mainly travel in the inshore area between the two proposed test area locations with less cargo vessel activity further offshore.
- Recreational activity is rare during winter.
- The main vessel route as the vessels travel around Erris head and continue down along the coast passing outside the islands off the coast of Mayo is again very noticeable.

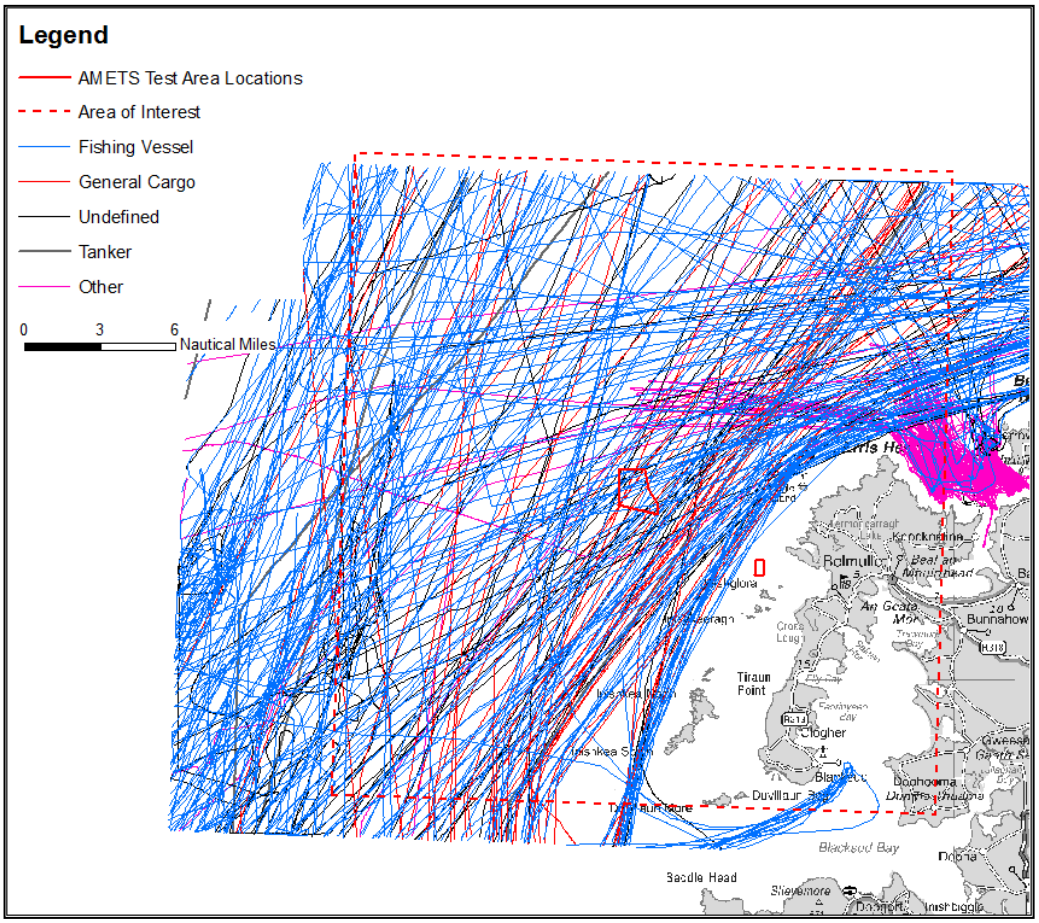

Figure 67 January 2010 AIS Tracks colour-coded based on Vessel Type

Meanwhile Figure 68, which includes July 2010 AIS tracks, confirms some of the conclusions drawn from the Summer Survey data assessed previous.

- With a relatively small number of fishing vessels carrying AIS, it confirms that fishing vessel activity is primarily confined to smaller vessels during the summer period. These smaller vessels were identified by radar during the Summer Survey.
- Increased cargo activity during the summer with the main route along the coast similar to that seen during the winter. There is a tendency for vessels to take routes further offshore during the summer also. Vessels working on the Corrib gas installation are again evident to the north of the Test Area A.
- Recreational activity arises during summer. Again it is important to note that recreational craft would generally not carry AIS and have not been accounted for in this additional data.
- Evidence of a lot of activity close to both test area locations cannot be seen. Thus the activity close to the test area locations seen during the Summer Survey can be attributed to the vessels which were recorded by radar.

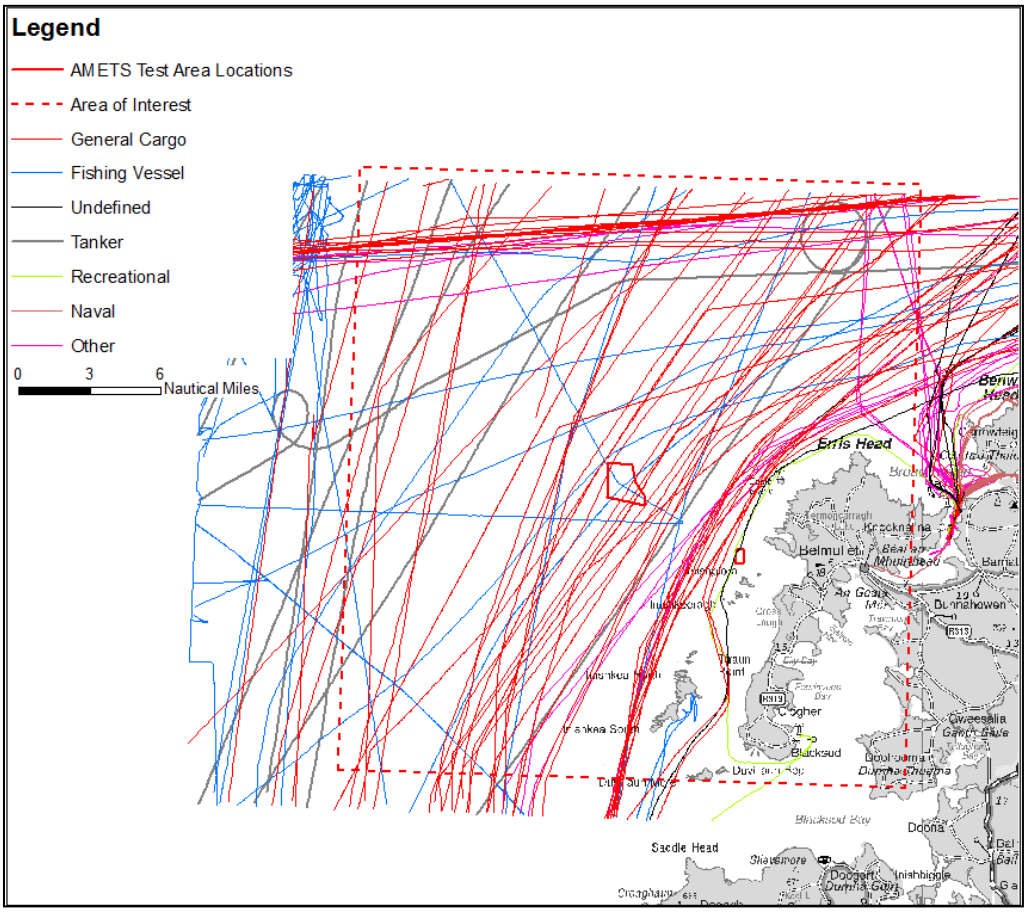

Figure 68 July 2010 AIS Tracks colour-coded based on Vessel Type

8 Risk Assessment

8.1 Scope and Depth of the Risk Assessment

An initial assessment of the potential navigation traffic near the site was conducted at preliminary stage to decide upon the scope and the depth of the risk assessment (ref. [6]). The assessment revealed that the shipping activity off the coast of Belmullet was small compared to other areas where similar offshore developments have been constructed.

UK DTI Guidance states that the scope and depth of the risk assessment, together with the tools and techniques necessary to carry this out, should be proportionate to the:

- Scale of the development; and
- Magnitude of the risks

Therefore, it is considered that the AMETS development is a "Low Risk, Small Scale Development", (i.e. "a development in an area where the potential risks are low, and/or a small scale development"), which only requires a submission based on a:

- Hazard list,
- Navigation risk assessment based on qualitative techniques such as "expert judgement",
- Search and rescue overview,
- Emergency response overview,
- Risk Control List.

The AMETS risk assessment has been carried out using qualitative techniques, supplemented by semi-quantitive information gathered from the maritime traffic data collected. As per the UK DTI guidance, this approach is appropriate for the scale of the AMETS development.

8.2 Risk Assessment Process

Information was gathered from investigations, consultations and navigation traffic data. Using this information a hazard identification exercise has been carried out in line with the Formal Safety Assessment (FSA) explained in detail in section 8.3 below.

A comprehensive hazard log has been developed which documents all the hazards that are likely to exist in relation to navigation during all stages of the development (construction, operation and decommissioning).

The hazard log was used to further investigate navigation risks identified and to quantify their likelihood and consequence. Where possible hazards have been identified, this exercise has also been used to identify potential mitigation/control measures to be considered.

Items required to support the risk assessment such as, understating of future case scenarios, construction and decommissioning issues, navigation marking for the development, SAR resources etc. were investigated further to provide a better

understanding of the issues and potential constraints to risk control measures available.

8.2.1 Risk Assessment Inputs

The process of identification of hazards and development of mitigation measures was carried out with the involvement of project personnel, consultees and expert advisors as indicated in Table 8.2.1. The Risk Assessment and Hazard Log were prepared by Arup and circulated for comments and additions from these personnel.

Peter Widd	Master Mariner and Navigation Expert	Arup's Consultant
Alex Scott	Navigation Expert	Mojo Maritime
Hugh Barry	Operations and Training Officer	Coastguard
Capt Robert McCabe Capt Harry McClenahan	Inspector Assistant Inspector	CIL
Paddy Kavanagh	EIS preparation manager	ESBI
Julie Ascoop James Ryan	AMETS Project Manager Local Liaison Manager	Arup

Table 8.2.1 List of Personnel consulted in relation to Hazard Log

8.3 Formal Safety Assessment

The study has been developed in line with guidance given by the IMO Formal Safety Assessment process (SC/Circ.1023/MEPC/Circ392, 2002). A systematic risk analysis was carried out as per the guidance given by DTI Methodology and its proposed format.

The analysis progressed through the usual five basic steps (Figure 69):

1. Identification of hazards (with the use of casual chains);
2. Assessment of risks (as a combination of probability and consequence and taking into consideration the appropriate risk factors);
3. Risk control options (devising Assets, Rules and Good practices measures to control and reduce the identified risks);
4. Cost benefit assessment (determining cost effectiveness of risk control measures);
5. Recommendations for decision-making (summary of the hazards, their associated risks and the cost effectiveness of risk control measures).

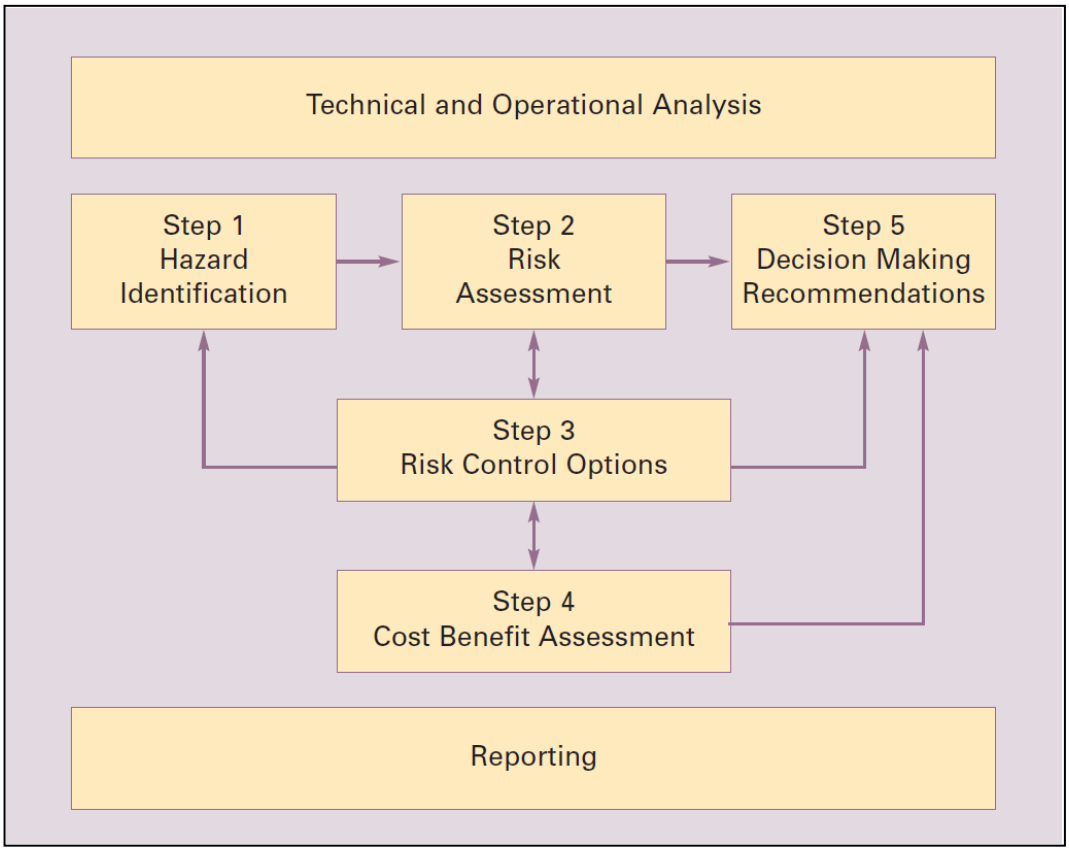

Figure 69 Overview of formal safety assessment

Frequency bands and Consequence bands were adopted in the IMO style and are illustrated in the two tables below taken from the DTI Methodology.

Frequency	Frequent	Likely to happen (to a wind farm) yearly or more frequently.
	Reasonably Probable	Likely to happen during the licence period of a wind farm (nominally 20 years).
	Remote	Unlikely (but not exceptional) to happen during the licence period.
	Extremely Remote	Only likely to happen in exceptional circumstances.

Table 8.3.1 Frequency bands

No significant harm to people	Injury to vessels crew Injury to turbine installation or maintenance crew Injury on the shore	Loss of a vessel crew member(s) (1 to 3) Loss of a turbine installation or maintenance crew member(s) (1 to 3) Fatality(ies) on the shore (1 to 3)	Total loss of a vessels crew Total loss of a turbine installation or maintenance crew Multiple fatalities on the shore
Insignificant	Minor	Major	Catastropic
Consequence to People			

Table 8.3.2 Consequence bands

Criticality was also assessed in the IMO style based as a product of Frequency and Consequences. Details are given in the table below from the DTI Methodology.

Frequency					
	Frequent	4	5	6	7
	Reasonably Probable	3	4	5	6
	Remote	2	3	4	5
	Extremely Remote	1	2	3	4
		Insignificant	Minor	Major	Catastropic
		Consequence			

Table 8.3.3 Criticality Matrix

The tolerability of risk was then assessed on the basis of Tolerability Matrix proposed by the DTI methodology.

Risk Criticality		Condition	Explanation
7	Unacceptable		Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
6	Unacceptable		Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
5	Tolerable with Modifications	with a commitment to further risk reduction before construction	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class of 4 or below before construction
4	Tolerable with Additional Controls	with a commitment to further risk reduction before operation	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class 3 or below before operation
3	Tolerable with Monitoring	with a commitment to risk monitoring and reduction during operation	Risk must be mitigated with engineering and/or administrative controls. Must verify that procedures and controls cited are in place and periodically checked
2	Broadly Acceptable		Technical review is required to confirm the risk assessment is reasonable. No further action is required
1	Broadly Acceptable		Technical review is required to confirm the risk assessment is reasonable. No further action is required

Table 8.3.4 Risk Tolerability Matrix

The details and the conclusions of the Formal Safety Assessment Process have been inserted in the Hazard Log included in Appendix A built according to the format proposed by the DTI methodology.

Cost benefit analysis was considered throughout the development of mitigation and control measures. The measures suggested have included a consideration of the benefit gained by the development for the cost outlaid (i.e. marking of the test site with appropriately sized buoys etc.).

8.4 Hazard Log Findings

A detailed Hazard Log is presented in Appendix A. Included within the hazard log is the hazard identification process to make sure all foreseeable hazards are included, the risk assessment process and the risk control options in relation to each hazard. The cost benefit analysis was incorporated when identifying possible risk control options.

An outline of the findings of the Hazard Log is given in the sections below. The hazard log should be referred to for further detail.

8.4.1 General Navigation Safety

8.4.1.1 Collision

- Potential hazards include fishing, in transit, anchored, recreational, special event or AMETS operating vessels colliding in or around AMETS.
- The risk tolerability was quantified as 'Broadly Acceptable' in all instances relating to collision.
- The risk was deemed so assuming that all safety controls mentioned in relation to this hazard are implemented including: Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Promulgation of information and warning through radio navigation warnings, notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts in order to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; etc.

8.4.1.2 Contact

- Potential hazards included a vessel under control or a vessel drifting making contact with WEC or buoy.
- The risk tolerability was quantified as 'Tolerable with Monitoring' in both instances. Whilst likely consequence is seen as minor, the possible frequency has been seen as remote in both cases.
- Some risk controls cited in particular for these hazards include: Location, alignment, size and layout optimised; Lighting of individual structures on site; Site located away from main vessel routes; Position monitoring of WECs and buoys to ensure position stationary.

8.4.1.3 Grounding and Foundering

- Vessel grounding or becoming stranded due to restricted manoeuvring because of AMETS was identified as a hazard.
- The risk tolerability was quantified as 'Broadly Acceptable' once risk control measures in place.
- Risk control measures are similar to those mentioned for collision and contact hazards.

8.4.2 Other Navigation Safety

8.4.2.1 Foundering and Capsizing

- A potential hazard may exist if a vessel towing fishing equipment snags a subsea obstacle causing the vessel to founder or capsize.
- The risk tolerability was quantified as 'Broadly Acceptable' once risk control measures in place.
- Some particular risk controls mentioned for this hazard are: Site location to be communicated to fishing organisations and fishing grounds to be reduced to avoid test area; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of fishing gear snagging on a subsea obstacle; Marking of site on navigation charts in order to inform fishing vessels of site and give them opportunity to plan alternative fishing route; Define and agree with fishermen a procedure for retrieving fishing gear if the gear ends up within the site which may help prevent interference with subsea equipment within site.

8.4.2.2 Machinery Related Accidents

- Machinery related hazards identified are if WEC failure resulting in debris entering seaways and failure of WEC navigation aids resulting in non detection of AMETS.
- These risks were quantified as 'Broadly Acceptable' based on the risk control measures that can be implemented.
- Some particular risk control measures for these hazards include: Site located away from main vessel routes identified to reduce chance of vessel encountering floating debris from site; Ensure WEC and buoy integrity reducing need for maintenance and therefore reducing chance of failure and parts floating away from device.

8.4.2.3 Accidents to Personnel

- There are a number of hazards in relation to accidents to personnel requiring SAR and/or emergency response. Accidents caused by transfer to/from servicing vessel to a WEC or another vessel requiring SAR response , accidents onboard WEC requiring emergency rescue of servicing personnel and accident resulting person in water requiring rescue.
- The risk tolerability relating to transferring between vessels and WEC and relating to person in water were defined as 'Tolerable with Monitoring'. This was mainly due to the fact that the frequency of these hazards occurring over course of licence period was felt to be reasonably probable. The tolerability of the risk of accident onboard a WEC requiring emergency rescue has been quantified as 'Broadly Acceptable' as the frequency has been described as extremely remote with little chance of an accident occurring requiring emergency rescue.
- Some particular risk controls mentioned for these hazards are: Personal protective equipment compulsory for all personal on site to ensure safety; Site personnel trained appropriately to assist in event of accident; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather;

Ensure WEC and buoy integrity reducing need for maintenance and therefore reducing servicing vessel activity at the test site; Use certified equipment when carrying out transfers

8.4.2.4 Electrocution

- There are a number of potential hazards resulting in electrocution. Vessel hitting WEC sufficiently hard to pierce and breach cable insulation and an anchoring vessel dragging up export cable and shorts cable to anchor are the hazards identified.
- The risk tolerability relating to vessel hitting WEC and piercing cable and relating to an anchoring vessel dragging up cable and shorting to anchor have both been quantified as 'Broadly Acceptable'.
- Some particular risk controls mentioned for these hazards are: Guard vessel during construction/decommissioning to protect vessels and to alert navigating vessel of operation; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of vessel anchoring above cable

8.4.3 Search and Rescue

- The presence of AMETS is cited as a hazard increasing the risk of an accident requiring SAR and also may hinder SAR operations.
- The risk tolerability has been quantified as 'Tolerable with Monitoring'. Whilst likely consequence is seen as minor, the possible frequency has been seen as remote.
- Some particular risk controls mentioned for these hazards are: Marking of site on navigation charts in order to inform SAR vessels of site and give them opportunity to plan alternative routes to take in event of emergency; Marking and Lighting of individual structures to make all structures clearly visible during night and day if a SAR operation requires SAR personnel to enter site; SAR response planning to outline procedures in case of emergency; SAR training;

8.4.4 Emergency Response

- The presence of AMETS is cited as a hazard increasing the need for emergency response and also may hinder ability to provide emergency response.
- The risk tolerability has been quantified as 'Tolerable with Monitoring'. The typical consequence is seen as minor and the possible frequency has been seen as remote.
- Some particular risk controls mentioned for these hazards are: Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily navigatable in the event of emergency operation; Salvage response planning to outline procedures in place in event of emergency; Salvage asset provision planning inorder to ensure necessary salvage equipment in place;

9 Risk Assessment Further Consideration

9.1 Future Case Scenario

Based on the consultation meetings carried out during the project, no proposals were identified which are likely to significantly increase the levels of shipping activity in the immediate area of the AMETS, other than that associated with the AMETS development itself.

In terms of fishing, future changes are more difficult to predict as various external factors may have an influence. Consultations have suggested that fishing activity may be at a peak now as more and more labourers from the construction sector have reverted to fishing in search of a source of income. Should other industry sectors improve in the next few years, it is expected that fishing activity will reduce.

There is also the potential for future oil and gas sector exploration in the area off the west coast. The traffic resulting from this exploration is not deemed to be a significant risk. Vessels involved in surveying, site investigations etc. will more than likely only transit past the site on an infrequent basis.

9.2 Construction and Decommissioning

9.2.1 Introduction

In addition to the risks and hazards during the operation of the site, potential impacts during the construction and decommissioning of AMETS are also expected. These have been considered during the hazard identification process and are reported in the Hazard Log.

In general, the same hazards apply to the construction and decommissioning phases of the project as during the operational and maintenance period.

Additional hazards which are distinctly associated with the installation of WECs are also expected and require specific risk assessments and control measures.

9.2.2 Installation and decommissioning operations

A total of four electricity submarine cables will be deployed. Two cables will be deployed to Test Area A at 100m water depth and two to Test Area B at the 50 m water depth. The distance from Belderra Strand to Test Area A is 16.6km and to Test Area B is 8km.

The following are the main activities that will be associated with the implementation of the project:

- Marking of the designated Test Areas with Cardinal marker buoys
- Construction of the cable joint bay at the car park of Belderra Strand
- Deployment of the subsea cable including:
- Cable landfall including onshore cable installation to cable transition joint bay and winching of cables onshore

- Near shore shallow water operations (e.g. digging a trench for cable duct)
- Offshore deep water cable laying
- Offshore cable protection including cable burial or surface protection
- Installation of landside underground cable
- Construction of substation
- Deployment of WECs within Test Areas including connection to subsea electricity cable and anchoring
- Commissioning

Decommissioning of the subsea portion of the cable will be subject to agreement between SEAI, the Minister of Communications, Energy and Natural Resources, and other appropriate authorities and will be in line with relevant legislation and industry best practice at the time.

A full assessment of the impact of decommissioning will be undertaken. This will include the options of recovering the sub-marine electricity cables as opposed to leaving them in situ.

9.2.3 Hazards during construction and decommissioning

During the construction phase of the site, the presence of construction vessels and the likely additional vessel movements to the operations bases in order to supply and re-crew the operations, will pose an additional navigational risk.

The Maritime Safety Division of the Department of Transport will be contacted regarding the production of a marine notice to describe the works and give commencement and completion dates for the same. The notice will be promulgated at least four months prior to work commencing.

All vessels employed in relation to the development will comply with all statutory regulations and will be of sufficient size to cope with the works and the adverse weather conditions.

9.2.4 Hazards during installation and decommissioning of WEC

The hazard log completed for this navigation risk assessment has identified hazards which will be relevant in the construction and decommissioning phases of the project.

However the hazards and potential control measures brought in by different WEC will not be known until the devices, construction methods and vessels/contractors have been defined.

WEC developers will include the hazards relevant to their device in the device specific navigation risk assessment that will be prepared before the WEC is installed.

The construction work will be planned and managed to ensure the safety of those involved and other maritime users in this area. This will include the selection of contractors and the working vessels to ensure they are competent/capable of undertaking the works required, and also following offshore industry guidance and best practices.

9.3 Navigational Marking

Marine navigational marking will be provided in accordance with CIL requirements, and will comply with the IALA standards.

9.3.1 Construction and decommissioning

During the construction and decommissioning of the site and of any WEC, working areas will be established and marked in accordance with the IALA Maritime Buoyage System (MBS).

Notices to Mariners, Radio Navigational Warnings-NAVTEX and/or broadcast warnings will be promulgated in advance of and during construction / decommissioning of any the devices construction/decommissioning.

Consideration should be given to assuring that a guard vessel is utilised to monitor and warn traffic during the construction phase.

9.3.2 Safety Zones

In order to minimise risks to vessels navigating in the area and the devices, it would appear appropriate that the test site areas (A & B) be designated as an Area to be Avoided (ATBA).

An Area to be Avoided (ATBA) is a routeing measure comprising an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships or certain classes of ships.

It will not be desirable for vessels to navigate through the site. There will be a number of devices, mooring lines and cables within the site area. The devices can be low freeboard floating structures with surface piercing and subsurface elements which may extend laterally beyond the surface elements. In some configurations, moorings can be shared by two devices adding to the complexity of the system. Cables will more likely than not be connected to the WEC to carry electricity and control signals.

Given the potential hazards of collision and entanglement of fishing gear with cables/mooring lines it is assumed that all fishing activity (e.g. trawling, potting etc...) will be prohibited within the defined ATBA. The ATBA would be marked on all hydrographic charts covering the area.

However, an ATBA is likely to require approval by the International Maritime Organisation. The time required to complete this approval process may be unsuitable for the programme of this development. Therefore, as a minimum it is proposed that a Safety Zone, equivalent to that used to mark restricted areas around windfarms, is applied over both test site areas.

The site layouts have been designed considering the position of

WEC arrays, proposed mooring layout, potential for lateral movements of the WECs and clearance areas. The boundary of the test site areas outlined in the figures will form the boundary of the Safety Zone. Safety Zones will be established and will define an area in which all vessels, other than authorised

vessels and vessels seeking refuge in an emergency or emergency service vessels themselves are not allowed to enter.

9.3.3 Marking of test site areas

Schemes for marking of the test site areas have been considered for the purposes of completion of the consenting process. The test site marking will be finalised on consultation with national authorities and in line with guidance.

The following provisional marking has been considered:

- Test Area A:
  - South east corner: One large scale buoy which could include power (solar), AIS and Racon transmitters and receivers and navigational marking such as lights
  - South west, north west and north east corners could have cardinal marker buoys with navigational marking such as lights
  - Remaining eastern side buoys can be special marker buoys with navigational marking such as lights
- Test Area B:
  - South west and north west corners could have cardinal marker buoys with navigational marking such as lights
  - South east and north east corners could be special marker buoys with navigational marking such as lights

In order to avoid confusion from a proliferation of lights consideration will require to be given to the use of synchronised lighting, different light characters and varied light ranges. The final size of the buoys will be confirmed by CIL

9.3.4 Marking of individual structures

Details of individual devices are unknown at this stage. However the marking of each WEC installed in the site will be in accordance with the IALA standards and agreed with CIL.
In general, WECs should be:

- equipped with lighting (yellow lights with a nominal range of 2 NM with a flashing sufficiently different from that of the cardinal buoys)
- equipped with passive radar reflectors
- made of retro reflecting material
- yellow painted above the waterline

9.3.5 Inspection, maintenance and contingency plans

A reliable inspection, maintenance and casualty response regime will need to be implementing to ensure that the required availability targets specified in IALA standards are met (See Chapter 3 of IALA Navguide – Aids to Navigation Manual ref [8]

Any Aids to Navigation required in connection with the test site and the WEC will be subject to the CIL inspection and audit regime

The Aids to Navigation will need to meet the levels of availability specified in the IALA standards (Category 2).

Consideration will need to be given to the wave climate in the area and the frequency of weather conditions suitable for ensuring safe access for repair/replacement of Aids to Navigation.

9.4 SAR Response

9.4.1 Introduction

The following section looks at the issues in relation to Search And Rescue (SAR) response. Through consultation with the relevant bodies a brief outline of the level of accidents in the area of the proposed test site was established. A detailed look at the SAR resources available in the event of an incident in the vicinity of the AMETS is also included in this section.

9.4.2 Maritime Incidents

It is likely that a higher number of incidents of vessels breaking down, drifting etc. occur in this area than are documented. This is due to the fact that the first response of a vessel is to call a nearby vessel for assistance. It is usually a last resort that SAR teams are contacted.

Records of marine incidents are available from the Marine Casualty Investigation Board (MCIB) and from consultation with local fishermen and the Ballyglass RNLI.

9.4.2.1 MCIB

The Marine Casualty Investigation Board (MCIB) set up in June 2002 carry out investigations into marine casualties that take place in Irish waters or which involve Irish registered vessels.

Marine Casualty means an event or process, which causes or poses the threat of:

- death or serious injury to a person;
- the loss of a person overboard;
- significant loss or stranding of, damage to, or collision with, a vessel or property; or
- significant damage to the environment,

in connection with the operation of:

i. a vessel in Irish waters;
ii. an Irish registered vessel, in waters anywhere; or
iii. a vessel normally located or moored in Irish waters and under the control of a resident of the State, in international waters contiguous to Irish waters.

The purpose of each investigation is to:

1. Establish the cause or causes of a marine casualty.

2. Report on the marine casualty with a view to making recommendations for the avoidance of similar marine casualties.

Since the board's establishment in 2002, investigation of marine casualties in the region of the AMETS development has been relatively rare. Since 2002, eight incidents have been investigated by the MCIB off the west coast between Mayo and Donegal. Only two of these incidents have been close to the mullet peninsula:

1. Porturlin 2010: Sinking of the inshore fishing vessel, Léim an Bhradán approximately 12-15 miles north of Porturlin, Mayo. Both crews were rescued with no fatalities.
2. Erris head 2005: Washing overboard of a crewman from the 9 meter yacht "Gibsea". The yacht was recovered approximately one nautical mile north west of Erris head. One fatally occurred.

9.4.2.2 Local SAR records

Limited historical data is available in relation to maritime incidents in the region of the AMETS. According to the RNLI, on average the lifeboat at the Ballyglass RNLI station is called out 28-30 times per year. The calls seeking help are mainly as a result of mechanical failure of vessels, capsized yachts or due to fire on-board vessels. The RNLI responses in the event of an incident are rarely required to venture beyond the 100m deep contour. Occasionally they have been required to travel out this distance to assist trawlers travelling in the area.

9.4.3 SAR Resources

9.4.3.1 RNLI Lifeboats

The Royal National Lifeboat Institution (RNLI) operates 43 lifeboat stations throughout the Republic of Ireland and Northern Ireland. There is a RNLI station in close proximity to the AMETS at Ballyglass, Co. Mayo. The location of Ballyglass RNLI lifeboat station is shown in Figure 70.

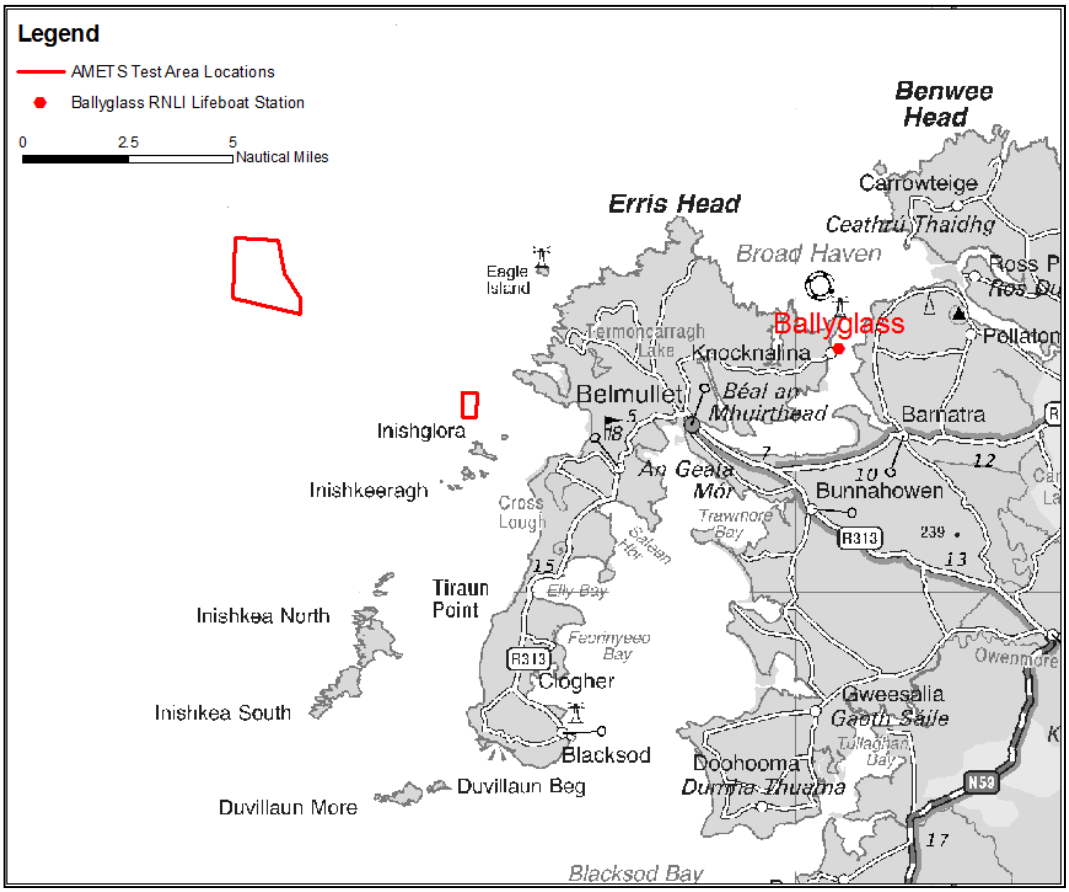

Figure 70 Location of Ballyglass RNLI lifeboat station in relation to the AMETS

At the Ballyglass RNLI lifeboat station crew and lifeboats are available on a 24-hour basis throughout the year. Table 9.4.1 provides a summary of the craft available to crew at the Ballyglass RNLI lifeboat station.

Lifeboat Vessel	Class	Length	Range	Speed	Weight	Crew	Launch Type
Bryan and Gordon	Severn	17m	250NM	25knots	41tonnes	6	Moored Afloat
The Western	D	5m	3hours at max speed	25knots	436kg	2/3	Trolley or Davit

Table 9.4.1 Ballyglass RNLI lifeboat vessels

The Severn class lifeboat (Bryan and Gordon) can operate in all-weather. The 'Bryan and Gordon' is suitable for offshore operations. RNLI All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

The D class lifeboat (The Western) is small and highly manoeuvrable, making it ideal for rescues close to shore in fair to moderate conditions. 'The Western' is generally used by the Ballyglass RNLI crew when carrying out operations within the sheltered area to the East of the Belmullet peninsula including Blacksod bay. The RNLI class D lifeboats are equipped with VHF radio and GPS.

Approximate response times have been indicated by the RNLI crew at Ballyglass station. From the time of a distress call, the RNLI crew will mobilise to the water within 11-14min which includes the time it will take crew members to drive from Belmullet to Ballyglass. The expected total response time for the 'Bryan and Gordon' from the time of call is 40min to Test Area B and 70min to Test Area A.

9.4.3.2 Coast Guard Stations

The Irish Coast Guard (IRCG) has the responsibility to rescue people from danger at sea or on land, to organise immediate medical transport and to assist boats and ships within the country's jurisdiction.

The IRCG coordinates operations through its Marine Rescue Centres (MRCCs) which are currently based in Dublin, Malin Head (Co Donegal) and Valentia Island (Co Kerry). Each centre are 24/7 centres coordinating SAR response in their areas of responsibility which are outlined in Figure 71 below. The Marine Rescue Sub Centre (MRSC) Malin Head is the contact point for routine operational matters in the area between Clifden and Lough Foyle which includes the area within and surrounding the AMETS.

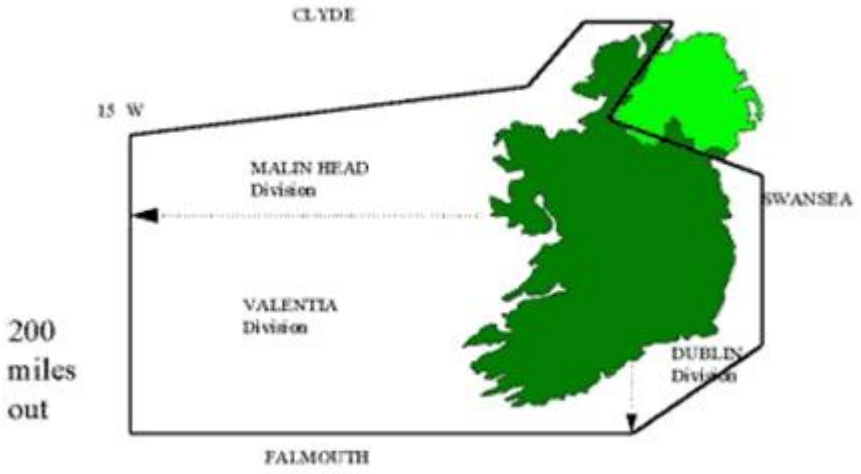

Figure 71 Areas of Responsibilities for Marine Rescue Centres (ref [8])

In the event of an incident at AMETS, SAR operations will be supported by decision support systems available to personnel at the MRCC/MRSCs which include SarMap, OilMap and ChemMap. These software packages enable incident management and recording; resource selection and alerting; logging and databases to predict the movement of drifting targets at sea; automated weather inputs and production of search areas and optimum search coverage plans for search units.

Maritime Safety Information (MSI) is broadcast over VHF and in some cases, MF radio by each MRCC/MRSC in accordance with published schedules. MSI includes navigational warnings as issued by the UK Hydrographic Office; Gale Warnings, Shipping Forecasts, Local Inshore Forecasts, Strong Wind Warnings and Small Craft Warnings as issued by the Irish Meteorological Office. This communications watch includes a distress watch on the international VHF distress frequency.

9.4.3.3 SAR Helicopter

The IRCG currently operates 6 medium-lift Sikorsky S61N helicopters (Figure 72) on contract from C.H.C. Ireland Ltd. All helicopters are on call to the Coast Guard 24 hours a day, 365 days a year.

Figure 72 IRCG SAR Sikorsky S61N Helicopter (ref [10]

These aircraft are based at Sligo, Shannon, Dublin and Waterford airports. Helipad fuel installations for refuelling are available to aircraft at other locations in the instances of extended range operations off the West Coast of Ireland. Figure 73 shows the aircraft bases and the approximate 150NM mile range of operation for Irelands SAR helicopters from base.

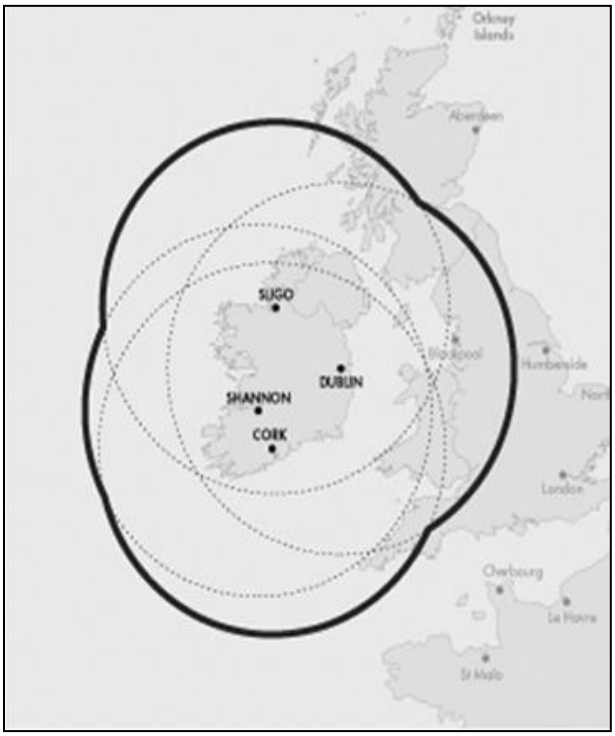

Figure 73 Aircraft bases and the Approximate Range of Operation from each Helicopter Base (ref [10]

According to the IRCG the expected launch times upon an incident being reported are as follows:

- Achieve launch time of 15 minutes on urgent calls from normal ground readiness between 0700 – 2100.
- Achieve a launch time of 45 minutes on urgent calls from normal ground readiness between 2100 - 0700.

The IRCG helicopter base in Sligo is closest in proximity to the AMETS. The base is approximately 55 NM to the East of the test site. The Sikorsky S61N helicopter located at Sligo has a maximum endurance of 4+ hours giving a radius of action of approximately 150NM which is well within range of the site.

9.4.3.4 Pollution and Salvage

The IRCG holds the responsibility for developing and coordinating an effective strategy for response to spills of oil and other hazardous substances within the Irish Pollution Responsibility Zone and for monitoring or intervening in marine salvage operations.

Some of the tasks undertaken by IRCG include:

- provides and maintains 24 hour marine pollution notification at the three Marine Rescue Centres

- develops approved pollution response plans in all harbours and ports, oil handling facilities, marine local authorities and offshore installations
- provides and maintains a national stockpile of pollution equipment
- co-ordinates exercises and tests of national and local pollution response plans on an ongoing basis

In terms of resources to aid in the event of an incident, the IRCG maintains national stockpiles of pollution response equipment at Killybegs, Castletownbere and Dublin. Killybegs is located approximately 65NM from the AMETS which would help to aid efforts to deploy equipment quickly in the event of an incident close to the AMETS. Regular exercises are carried out using these equipment stockpiles. The equipment as far as possible compliments the equipment held at the harbours and ports.

It is not economical for any country to have sufficient state equipment to respond to every possible pollution emergency. However, the IRCG have authority to contract additional equipment from commercial companies who will provide equipment on request and guarantee it will be on-site within 12/24 hours.

9.4.4 SAR Access to AMETS Area and SAR Commitments

In the event of an emergency the test site will be accessible by helicopter and boat.

For this scale of development an emergency call is made to Malin Head, from which the response would be coordinated. The type of response by the emergency services is dependent on the type of accident. Deployment of the Coastguard helicopter is the most likely first response, closely supplemented by the local RNLI lifeboat. The Coastguard would also investigate the location of other nearby SAR resources such as the Air Corps or Navy. The Dublin Coastguard may also be included for the site SAR procedures.

A helicopter will be unable to land on site, but access for winching of personnel should not be any different to that when being performed on small vessels at sea. Access by Ballyglass's larger Severn class vessel is not likely to be an issue but should be reviewed for each specific device installed. Up to date site layouts will be provided to RNLI and the option available for emergency exercises to be carried out if felt appropriate.

Where a larger vessel, perhaps a requisitioned vessel summoned by coastguard, may need to enter the site in the case of an emergency there is likely to be more of an issue based on the number and layout of devices, mooring lines, etc., which could pose a hazard to the vessel. The layout and characteristics of devices and associated cables and lines within the site should be provided to the coast guard and any tug operators who may assist in the event of an incident. It will be the responsibility of the AMETS Management Organisation to provide this information to the relevant organisations.Other duties in relation to SAR response the AMETS Management Organisation will be responsible for include:

Identify all scenarios to be considered within the emergency planning process. To identify these scenarios assess the risk associated with the AMETS site in line with the Health & Safety Management System (H&SMS).

- In forming of emergency response plans and operational procedures an effort should be made to involve all appropriate bodies. These bodies should include AMETS employees, appropriate contractors and external organisations such as:
  - IRCG
  - RNLI
  - Tug companies
  - Fire Brigade
  - An Garda Siochana
- Consult with each party to ensure they have all the relevant information required to carry out emergency response effectively if required. All SAR organisations should be provided with a site layout indicating the GPS position and details of all devices and equipment which is on site.
- The AMETS Management Organisation must be satisfied that the AMETS emergency systems and procedures can effectively accommodate the integration of the client's proposed device and equipment. Also to ensure updated site layout and information is circulated to the appropriate SAR organisations.
- Ensure a Personal Protective Equipment (PPE) program is in place for use by all AMETS employees working at the site and for those who may be involved in emergency response.
- Carry out trial emergency response procedures under realistic conditions to maintain competence and to further improve the H&SMS using any knowledge gained.
- Maintain suitable records of emergency responses that have taken place in an effort to further improve systems within AMETS Management Organisation.

9.5 Other Navigation Issues

9.5.1 Introduction

Important navigational issues in relation to the development of a wave energy test site are set out in MGN 371(ref [4]). This section looks to address some of the navigation issues not addressed previously in this report. A device specific assessment is required for each individual device to be located on site and this assessment should also refer to the navigational issues raised in MGN 371.

9.5.2 The Effects of Tides, Tidal Streams and Currents

The tidal streams in the area follow the coastline in the north and south direction. Moderately strong currents up to 1.5kn have been noted in the test site area. The currents have been noted as travelling predominantly in the NE-SW direction.

The test areas are located in open water which allows for vessels to avoid the development while taking account of the influence of tides and currents. The location of the test areas (A & B) is such that the influence tidal streams and currents have on navigation is unlikely to increase any known navigation hazards. Vessels should be aware of the tidal and current influence in the area and sail accordingly. The inclusion of the development on navigation charts, radio

navigation warnings and notices to mariners will inform users of the need to divert their course appropriately.

9.5.3 Weather

There are a number of potential navigation issues in relation to weather that may pose a threat. Due to the presence of bad weather, or restricted visibility conditions the site may present difficulties or dangers to vessels passing in close proximity. It is understood that with appropriate radio navigation warnings, notifications to mariners regarding the site location and with adequate Aids to Navigation and other navigation aids in place this treat can be minimised.

Offshore structures can create problems in the area for vessels under sail, such as wind masking, turbulence or sheer. Given the limited number of structures that will be present and the fact that a number of them will have low freeboard as well as the fact that vessels will be passing outside the safety zones no impact is likely.

The risk of the south-west prevailing wind in the area causing a vessel to drift into danger needs to be address. It is expected that adequate response facilities will be in place to limit the danger involved with drifting vessels. With the necessary communication and response procedures in place the time a vessel is drifting uncontrollable in proximity to the test site should be limited and thus the prevailing wind will not be significant.

9.5.4 Visual Navigation and Collision Avoidance

The possibility of an offshore structure blocking or hindering the view from a vessel has been identified as a possible threat to navigation safety. A vessel navigating in the vicinity of the test site may not be able to view adequately another vessel navigating in the area, the coastline or any other Aids to Navigations, landmarks, promontories, etc. Due to the relative sizes of the devices under consideration for installation and the size of the proposed test site it is not considered that this visual obstruction will be a significant issue. This should be reviewed however when devices are selected and the consideration given to this when positioning devices within the site.

9.5.5 Communication, Radar and Positioning Systems

There is not expected to be any significant impact to communication, radar and positioning systems due to the presence of AMETS. The effect, if any, of each WEC located at AMETS on communication, radar and positioning systems will be addressed in full within the device specific assessments which will be carried out prior to installation.

10 Device Specific Risk Assessment and Site Management

10.1 Device Specific Risk Assessment

At this stage of the project the risk assessment is generic and not device specific.

The assessment looked at the site area as opposed to the individual devices. General issues which could relate to some of the devices that may be installed in the site were discussed during the Hazard identification process, however these issues are not meant to be exhaustive nor to include all the possible issues related to any device.

A specific risk assessment shall therefore be completed for each individual device prior to installation at the site.

10.2 Site Management

The 'AMETS Management Organisation' will have the responsibility of managing the construction and operation of AMETS. It will be the AMETS Management Organisation's role to implement an H&SMS covering all aspects of the operation.

The recommendations arising from this navigation risk assessment will be used to inform the marine element of the H&SMS. The risks identified throughout the course of this assessment will be managed within the H&SMS as the AMETS Management Organisation prepare, implement, review and monitor adequate operating procedures. The risk control measures described in relation to each risk will be considered during this process.

Aspects including marking of the test site on navigation charts, coordination of radio navigation warnings and notifications to mariners etc. will be managed by the AMETS Management Organisation.

11 Results and Conclusions

The following section outlines the Navigation Risk Assessment results and conclusion. The results and conclusions of the have been established by:

i. the collection and interpretation of data (environmental, maritime traffic etc.)

ii. consultation on the impact of the development with users and stakeholders; and

iii. carrying out a risk assessment based on the Formal Safety Assessment (FSA) procedure.

11.1 Collection and Interpretation of Data

11.1.1 Existing Environment

Information about the existing environment relating to navigation in the area was gathered to supplement the Navigation Risk Assessment. This included information on local ports and harbours, standard sailing routes, existing Aids to Navigation, known navigation hazards, industry activity, metocean data, bathymetry, fishing grounds etc. No significant impact to navigation was identified on assessment of the existing environment.

The data and information regarding the existing environment was also used to inform the risk assessment carried out for the AMETS development. The information gathered in relation to existing fishing activities in the area of AMETS, has also been used to review the test sites impact on fishing grounds in the area. The possible impacts on fishing grounds have been considered during the selection of the location and size of both test areas which is discussed in greater detail in the Chapter 3 of the EIS: Project alternatives.

11.1.2 Maritime Traffic Survey

The results of the traffic survey carried out are summarised below:

- It was determined through the breakdown of vessels by ship type that fishing vessels are the dominant ship type navigating in the area during both seasons. Fishing vessel activity accounted for 80% and 53% for winter and summer periods respectively. Increased commercial and recreational activity is present during the summer period.
- The daily traffic levels seen during both periods were relatively low. According to the average number of tracks per day, slightly more vessels travelled through the Area of Interest during the winter (8.6 tracks) than during the summer (7.1 tracks). However it was noted that the highest number of tracks identified during one day was 24 and occurred during the Summer Survey. The numbers of vessels navigating can differ greatly from day to day which is evident by the fact that no vessels were seen on one day during the Summer Survey.
- Vessel Tracks Density and Vessel Time Density plots for both periods have shown the areas of highest vessel activity. During the winter season

the main area occupied by vessels was in the inshore area along the coast as vessels navigated around Erris head. The Summer Survey shows increased number of smaller vessels fishing in areas closer to the Test Area A.

- The number of encounters, vessels passing within 1NM of each other, during the both surveys was relatively small. There were a small number of encounters close to Test Area A while there were no encounters close to Test Area B. There is no concern regarding the number of vessels navigating close to one another in the area surrounding AMETS and shows the risk of collision to be minimal.
- The site specific analysis of both test areas illustrates the level of activity within both areas. The analysis identified 12 tracks and 10 tracks travelling through Test Area A during the Winter and Summer Surveys respectively. The maximum number of vessels travelling through the site on any one day during the survey was three vessels. This analysis confirmed the low level of vessels navigating in Test Area A and the minimal impact the Test Area A will have on vessels navigation. This was also evident for Test Area B with no vessel travelling in the area during winter and only three vessels during the summer.
- Results of the analysis drawn from both survey periods were reaffirmed by assessing plots of AIS data received for January and July 2010.

Furthermore the potential impacts on some of the main vessel types in the area of interest surrounding AMETS assessed within the analysis have been considered within the following subsections.

11.1.3 Potential impacts on fishing vessels

Based on the preceding analysis it is concluded that the location of AMETS is unlikely to have an impact on the fishing vessel traffic navigation in the area.

A number of fishing vessel tracks passed through the AMETS Test Area A during the Winter Survey period. Almost all tracks appeared to indicate vessels transiting rather than actually fishing in the area of the AMETS. Based on the data collected, the impact of re-routing ships to avoid the Test Area A is likely to be small as there is substantial sea-room to the east and west of Test Area A. No vessels were noted in Test Area B during the winter survey.

The intensity of fishing in the vicinity of the AMETS was also low during the summer survey. Based on the data observed, the impact that the test sites will have on fishing traffic in the region is likely to be minimal. There may be signs of summer trawling in the areas surrounding Test Area A, therefore routes to and from these grounds may have to be altered to avoid the AMETS. The impact in this case should be limited as only a small number of tracks have been seen to pass through the Test Area A while in transit to these fishing grounds.

There appears to have been some fishing activity (more than likely to be potting) carried out within the proposed Test Area A during the summer survey, with the presence of a three twisted tracks. There may also have been some fishing activity within Test Area B as one fishing vessel was noted in the area during the summer survey, however the vessel path and activity is unclear. Access to the test areas

will no longer be available once the development is in place, however due to the small number of tracks observed; the impact is unlikely to be significant.

The overall navigational impact on fishing traffic in the area is not considered significant. Local users will be the most up to date with the development of the site and have in general confirmed that, once that the site is indicated on charts, they will sail and fish around it.

11.1.4 Potential impacts on commercial vessels

In terms of the additional sailing distances for commercial shipping, given the typical voyages of vessels on the routes affected and the relatively small (if any at all) displacement of the routes, there is not considered to be a significant commercial impact as a result of the AMETS development.

The promulgation of information to international users and marking on Admiralty charts will be critical to minimising risk of collision. Many larger ships sail on autopilot, making it paramount that the site is input when calculating the route.

11.1.5 Potential impacts on recreational vessels

Based on the data collected and consultations with recreational users of this area, it is considered that the proposed location of AMETS will have a minimal impact on the recreational vessel activity in the area. Marking of the test site with navigation buoys and on navigation charts is critical for recreational users.

11.2 Consultations

Consultations were carried out with all groups, organisations and agencies with a stake and/or interest in the waters off the west coast of Ireland, in particular the region off the Mayo coast. The following was concluded from all consultations carried out:

1. Standard navigation routes to areas north and south of the AMETS location, follow the coastline with change points west of Eagle Island. Navigation routes are likely to be altered slightly as a result of the AMETS development, however it is not envisaged that this will have a significant impact on users of the area.
2. Local navigation (fishing, recreational etc.) is arbitrary. The AMETS development will cause vessels to sail around the area, however this is not perceived to be a significant issue to users of the area.
3. SAR response in the area will not be negatively impacted upon by the AMETS development.
4. The AMETS development should be appropriately marked using Aids to Navigation and other navigation aids (buoys, AIS, Racon etc.) and included in navigation charts and notices to mariners. Navigation buoys used should be suitable for the sea conditions in the area.

11.3 Risk Assessment

A navigation risk assessment has been carried out in line with the appropriate guidance for offshore renewable energy developments. The risk assessment was informed by:

1. Environmental data for the area in question
2. Consultations with users of the area, statutory bodies and stakeholders
3. An analysis of navigation traffic data
4. Technical input from industry experts

A comprehensive hazard log has been developed with all risks identified, and their likelihood and consequence assessed. Where possible hazards have been identified, this exercise has also been used to identify potential mitigation/control measures to be considered.

Items required to support the risk assessment such as, understating of future case scenarios, construction and decommissioning issues, navigation marking for the development, SAR resources etc. were investigated further to provide a better understanding of the issues and potential constraints to risk control measures available.

11.3.1 Risk Assessment Conclusions

The majority of the risks identified are 'Broadly Acceptable' provided the risk control measures outlined within the hazard log are put in place. A technical review by industry experts carried out as part of this report (See Section 8.2.1) confirmed that the risk assessment is reasonable. Therefore, once all the outlined control measures are in place, these risks require no further action.

The risks determined as 'Tolerable with Monitoring' (provided the necessary control measures are implemented as outlined within the hazard log) include:

- The risk of a vessel under control making contact with WEC or buoy
- The risk of a vessel not under command or drifting making contact with WEC or buoy
- The risk of accidents caused by transfer to/from servicing vessel (or helicopter) to a WEC or another service vessel requiring SAR and /or emergency response.
- The risk of a person in the water requiring rescue.
- The presence of AMETS increasing the risk of an accident requiring SAR and also the potential of AMETS hindering SAR operations.
- The presence of AMETS increasing the need for emergency response and also the potential of AMETS hindering the ability to provide emergency response.

It will be important that the AMETS Management Organisation verify that procedures and controls cited in relation to these risks are in place and periodically checked.

Further points of consideration identified as part of the risk assessment are briefly summarized below:

- Through consultation carried out during the risk assessment, no proposals were identified which are likely to significantly increase the levels of shipping activity in the immediate area of the AMETS
- During the construction phase of the site, the presence of construction vessels and the likely additional vessel movements (e.g. to supply and re-crew the operations, guard vessels etc.) may pose an additional navigational risk.
- According to the MCIB records and local SAR consultations, incidents in the vicinity of AMETS appear to be rare. Also it has been established that resources are in place to cope with most eventualities. SAR resources in the region identified include RNLI lifeboats, MRSC at Malin Head, SAR helicopters and pollution and salvage equipment.
- Due to the relative sizes of the devices under consideration for installation at AMETS and the size of the proposed test site it is not considered that the devices will pose a threat as visual obstruction, blocking or hindering the view from a vessel.
- Potential navigation issues can be reduced to acceptable levels by ensuring necessary mitigation measure are in place. For instance, to ensure navigation safety, appropriate radio navigation warnings, notifications to mariners about the test site location and adequate Aids to Navigation and other navigation aids (buoys, Racon, AIS) will help reduce the risk of restricted visibility in poor weather.

12 Recommendations

The following recommendations have been established based on the findings of the AMETS Navigation Risk Assessment:

1. The site will need to be adequately marked (appropriately sized buoys with AIS, equipped with radar reflection panels etc.), noted on navigation charts and included in radio navigation warnings and notices to mariners as necessary. The scheme design marking of the test site areas will need to be finalised on consultation with national authorities and in line with guidance documents.
2. The test areas should be sized to provide an adequate clearance around each device and buoy, accounting for the mooring arrangements of the devices and buoys etc. The outline of the Test Areas, as marked on the navigation charts, shall form the boundary of a Safety Zone equivalent to that used to mark restricted areas around windfarms. Vessels shall not be allowed to sail within the Safety Zone.
3. Control measures for frequent users of the area around the test site should be defined and managed by the test site management organisation. This may include measures such as defining and agreeing with fishermen a procedure for retrieving fishing gear that enters the site
4. Notices are required to be issued in advance of works on the AMETS development such as: construction, decommissioning and the installation of any device;
5. The construction and decommissioning work should be planned and managed to ensure the safety of those involved and other maritime users in this area. This should include the selection of contractors and the working vessels to ensure they are competent and capable of undertaking the works required, and also in compliance with offshore industry guidance and best practices.
6. Consideration should be given to providing a guard vessel during the construction /installation and decommissioning phases of the project;
7. Electricity cables will require to be buried or alternatively be protected sufficiently with rock armour in order to minimise the risk of damage by fishing vessels and mooring operations.
8. A separate device-specific risk assessment which outlines the hazards relevant to the WEC will need to be prepared before WECs are installed in the AMETS. The device-specific risk assessments should be considered by the test site management organisation and read in conjunction with the findings of this assessment.
9. A reliable inspection, maintenance and casualty response regime will need to be implemented to ensure that the required availability targets specified by IALA standards are met (See Chapter 3 of IALA Navguide – Aids to Navigation Manual ref [8]
10. It is important that both the RNLI and other emergency services understand the layout and workings of the site and are involved in emergency exercises for the site. SAR should also be covered by each device specific risk assessment.

References

[1] DTI (Department of Transport). Guidance on the assessment of the impact of offshore wind farms: Methodology For Assessing The Marine Navigational Safety Risks Of Offshore Wind Farms.

[2] MGN 371 (M+F) (August 2008). Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

[3] IMO MSC 83/INF.2 14 May 2007. Formal Safety Assessment. Consolidated text of the guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process (MSC/Circ.1023-MEPS/Circ.392)

[4] WETS_R_2020 Executive Summary Site Selection Study Final

[5] UK Hydrographic Office (2006) Admiralty Sailing Directions, Irish Coastal Pilot, NP 40, (17th Edition)

[6] Arup - WETS_R_5421_D6508-35 Preliminary Navigation Risk Assessment Issue 1

[7] Marcel Cure (May 2011) A Fifteen Year Model Based Wave Climatology of Belmullet, Ireland for SEAI.

[8] IALA (2010) NavGuide: Aids to Navigation Manual

[9]http://www.transport.ie/marine/IRCG/SearchRescue/index.asp?lang=ENG&loc=2101

[10] http://www.transport.ie/viewitem.asp?id=8606&lang=ENG&loc=2102

Appendix A

Hazard Log

Description				Hazard Identification									Risk Assessment															Tolerability	Risk Control								
													Without AMETS				With AMETS														Type			Effect			
Ref			Description of Casual Chain	Accident	Navigation Activities	AMETS Structures	Phase of Development	Structures and Features	Vessel Type	Conditions	Human Activities	Summary	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Navigation Risk Factors	Influences on Cause	Traffic Levels	Circumstances	Influences on Consequences	Non safety Navigation Consequence	Risk Tolerability	Description	Asset	Rule	Good Practice	Prevention	Mitigation	Emergency Response	Summary
1. GENERAL NAVIGATION SAFETY																																				
1	**1**		**Collision**																																	
1	1	1	Vessel navigating near/around AMETS collides with another vessel that is navigating near/around AMETS	General Navigation	Navigation on Passage	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Mistakes Lapse Slip	Two vessels navigating near or around the site collide outside the AMETS during regular navigation. This risk applies to all vessel types. These ships may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the site.	Extremely Remote	Minor	2	Major	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts in order to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning in order to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning in order to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																													Locate site away from main vessel routes established			•	•			
																													Promulgation of information and warning through notices to mariners and other appropriate media.			•	•	•		
																													Marking of site on navigation charts			•		•		
																													SAR response planning				•		•	
																													SAR asset provision planning				•		•	
																													Salvage response planning				•		•	
																													Salvage asset provision planning				•		•	
																													Requisitioned Vessels	•					•	
																													SAR - Lifeboats	•					•	
																													AMETS Support Vessels	•					•	
																													SAR Helicopter	•					•	
1	1	2	Vessel navigating around/through AMETS collides with another vessel that is navigating through AMETS.	General Navigation	Navigation on Passage	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	One vessel navigating through the site collides with another a vessel navigating around or through the AMETS. Travelling through the AMETS will be prohibited therefore vessels travelling through will be in violation of the law. Possible circumstances for entering the test site may include, fishermen trying to retrieve pots or vessel choosing to navigate through due to an emergency (e.g. avoiding collision with a long journey ship). This risk applies to all vessel types. The vessels involved may be enrooted to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Marking and lighting of individual structures to help navigate in the event of vessel entering test site. Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																													Locate site away from main vessel routes established			•	•			
																													Optimise location, alignment, size and layout.			•	•			
																													Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																													Marking and lighting of individual structures	•			•			
																													Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																													Marking of site on navigation charts		•		•			
																													SAR response planning				•		•	
																													SAR asset provision planning				•		•	
																													Salvage response planning				•		•	
																													Salvage asset provision planning				•		•	
																													Requisitioned Vessels	•					•	
																													SAR - Lifeboats	•					•	
																													AMETS Support Vessels	•					•	
																													SAR Helicopter	•					•	
1	1	3	Fishing vessel collides with another navigating vessel navigating near, around or through AMETS or the presence of fishing vessel causes collision between other navigating vessels	General Navigation	Navigation on Passage Fishing Operations	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	Fishing vessel (engaged in fishing operations) colliding with another vessel navigating near around or through AMETS or two vessels collide with each other while navigating due to the presence of a fishing vessel (engaged in fishing operations). This risk applies to all vessel types. The navigating vessels involved may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of travelling through the test site.	Extremely Remote	Minor	2	Major	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																													Locate site away from main vessel routes established			•	•			
																													Optimise location, alignment, size and layout.			•	•			
																													Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																													Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																													Marking of site on navigation charts		•		•			
																													SAR response planning				•		•	
																													SAR asset provision planning				•		•	
																													Salvage response planning				•		•	
																													Salvage asset provision planning				•		•	
																													Requisitioned Vessels	•					•	
																													SAR - Lifeboats	•					•	
																													AMETS Support Vessels	•					•	
																													SAR Helicopter	•					•	
1	1	4	Recreational vessel collides with another navigating vessel navigating near, around or through AMETS or the presence of recreational vessel causes collision between other navigating vessels	General Navigation	Navigation on Passage Recreational Activities	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	A recreational vessel collides with vessel navigating near around or through AMETS or two vessels collide with each other while navigating due to the presence of a recreational vessel. It is imagined that the construction of AMETS may see increased recreational navigation in the vicinity of the site with people coming to view the site. This risk applies to all vessels. The navigating vessel may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; AIS/radar problems/absence, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of travelling through the test site. Poor weather and poor light are expected to have but a marginal effect as recreational vessels are less likely to be out at see in bad weather or with low visibility.	Extremely Remote	Minor	2	Major	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Promulgation of information and warning through notices to mariners and other appropriate media (e.g. Kingfish charts) to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																													Locate site away from main vessel routes established			•	•			
																													Optimise location, alignment, size and layout.			•	•			
																													Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																													Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																													Marking of site on navigation charts		•		•			
																													SAR response planning				•		•	
																													SAR asset provision planning				•		•	
																													Salvage response planning				•		•	
																													Salvage asset provision planning				•		•	
																													Requisitioned Vessels	•					•	
																													SAR - Lifeboats	•					•	
																													AMETS Support Vessels	•					•	
																													SAR Helicopter	•					•	
1	1	5	Anchored vessel collides with another vessel navigating near, around or through AMETS or presence of anchored vessel causes collision between other navigating vessels.	General Navigation	Navigation on Passage Anchoring	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	Anchored vessel collides with a vessel navigating near, around or through AMETS or two vessels navigating near, around or through AMETS collide due to the presence of an anchored vessel. Anchoring of vessels in the area within or near AMETS is rare, and reasons for a vessel to anchor are related to an emergency (e.g. engine, steering failure) or inorder for maintenance to the site structures. This risk applies to all vessels. The navigating vessel may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to the presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the site, unpermitted action in the case of navigating vessel travelling through the test site.	Extremely Remote	Minor	2	Major	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																													Locate site away from main vessel routes established			•	•			
																													Optimise location, alignment, size and layout.			•	•			
																													Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																													Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																													Marking of site on navigation charts		•		•			
																													SAR response planning				•		•	
																													SAR asset provision planning				•		•	
																													Salvage response planning				•		•	
																													Salvage asset provision planning				•		•	
																													Requisitioned Vessels	•					•	
																													SAR - Lifeboats	•					•	
																													AMETS Support Vessels	•					•	
																													SAR Helicopter	•					•	

Description				Hazard Identification									Risk Assessment													Tolerability	Risk Control							
													Without AMETS				With AMETS												Type			Effect		
Ref			Description of Casual Chain	Accident	Navigation Activities	AMETS Structures	Phase of Development	Structures and Features	Vessel Type	Conditions	Human Activities	Summary	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Navigation Risk Factors	Influences on Cause	Traffic Levels	Circumstances	Influences on Consequences	Non safety Navigation Consequence	Risk Tolerability	Description	Asset	Rule	Good Practice	Prevention	Mitigation	Emergency Response	Summary
1	1	6	Vessel engaged in operations collides with another vessel navigating near, around or through AMETS or the presence of vessels engaged in operations causes collision between other navigating vessels.	General Navigation	All	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	A vessel engaged in operation collides with a vessel navigating near, around or through AMETS or two vessels navigating near, around or through AMETS collide due to the presence of a vessel engaged in operation. Vessel engaged in operations may include vessels carrying out construction and maintenance work at the AMETS. The navigating vessels may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; Ensure WEC and buoy integrity reduce need for maintenance and therefore reduce maintenance vessel activity in test site; Guard vessel during construction/decommissioning to protect vessels and to alert navigating vessel of operations; AIS fitted to all construction/maintenance vessels inorder for vessel activity to be shown on AIS monitors thus making users aware of activity; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place ; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																											Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																											Marking of site on navigation charts		•		•			
																											Ensure wave energy device integrity reducing need for maintenance			•	•			
																											Guard vessel during construction/decommissioning activities			•	•			
																											AIS fitted to all contruction and maintenance vessels	•			•			
																											Adverse weather working conditions policy			•	•			
																											SAR response planning			•		•		
																											SAR aset provision planning			•		•		
																											Salvage response planning			•		•		
																											Salvage aset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											AMETS Support Vessels	•					•	
																											SAR Helicopter	•					•	
1	1	7	Vessel engaged in a special event collides with another navigating vessel navigating near, around or through AMETS or presence of vessels engaged in a special event causes collision between other vessels.	General Navigation	Navigation on Passage Special Events	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	Vessels involved in regattas or competitions collide with a vesel navigating near, around or through AMETS or navigating vessels collide due to the presence of vessels involved in a regatta or competition. It is noted that an around Ireland race stage annually passes in the vicinity of the test site. This risk applies to all vessels. The navigating vessels may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, , unpermitted action in the case of a vessel travelling through the test site.	Extremely Remote	Minor	2	Major	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of collision; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site (e.g. contact event organisations and inform about the presence of the site); Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following collision; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																											Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																											Marking of site on navigation charts		•		•			
																											SAR response planning			•		•		
																											SAR aset provision planning			•		•		
																											Salvage response planning			•		•		
																											Salvage aset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											AMETS Support Vessels	•					•	
																											SAR Helicopter	•					•	
1	**2**		**Contact**																															
1	2	1	Vessel under control makes contact with a wave energy converter or buoy.	General Navigation Safety Risks	All	Energy Devices	Construction Operation Maintenance Decommissioning	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	A vessel navigating through the site collides with WEC or buoy. Travelling through the AMETS will be prohibited and vessels travelling through will be in violation of the law. Possible circumstances for entering the test site may include, fishermen trying to retrieve pots or vessel choosing to navigate through due to an emergency. Also AMETS construction or maintenance vessels may be travel within site during operations and be involved in contact. This risk applies to all vessel types. he navigating vessels may be enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route. The contact may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Remote	Minor	3	Major	Site Traffic Interrelations between Vessels Navigator Behaviour Other single vessel factors	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Energy Device Design Vessels	Major damage to device, possible that device will be set adrift, damage to cable and sub-surface equipment. Damage to the hull of the vessel, fouled propeller.	Tolerable with Monitoring	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of contact; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; Ensure WEC and buoy integrity reduce need for maintenance and therefore reduce maintenance vessel activity in test site; Guard vessel during construction/decommissioning to protect vessels and to alert navigating vessel of operations; AIS fitted to all construction/maintenance vessels inorder for vessel activity to be shown on AIS monitors thus making users aware of activity; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather; Marking and Lighting of individual structures to make all structures clearly visible during night and day; Position monitoring of WECs and buoys to ensure position stationary and not drifting; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following contact; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Guard vessel during construction/decommissioning activities			•	•			
																											SAR response planning			•		•		
																											SAR aset provision planning			•		•		
																											Salvage response planning			•		•		
																											Salvage aset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	
1	2	2	Vessel not under command or drifting makes contact with an wave energy converter (WEC) or buoy.	General Navigation	All	Energy Devices	Construction Operation Maintenance Decommissioning	Fishing Grounds Oil & Gas Installations	All	Weather Tides and local currents Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	A vessel not under command or drifting collides with WEC or buoy. Possible circumstances for unmanned vessel may be due to engine failure, sudden illness to personnel on board vessel or failure of anchor. This risk applies to all vessel types. The vessels may have been enroute to fishing grounds, to oil and gas installations nearby, or just passing by along an international route before losing control. The contact may be caused by; poor weather, tides and local currents, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Remote	Minor	3	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Interference	Current	Accidental Navigation	Energy Device Design Vessels	Major damage to device, possible that device will be set adrift, damage to cable and sub-surface equipment. Damage to the hull of the vessel, fouled propeller.	Tolerable with Monitoring	Locate site away from main vessel routes established			•	•			Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Guard vessel during construction/decommissioning to protect vessels and to alert navigating vessel of operations; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following contact; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Optimise location, alignment, size and layout.			•	•			
																											Guard vessel during construction/decommissioning activities			•	•			
																											SAR response planning			•		•		
																											SAR aset provision planning			•		•		
																											Salvage response planning			•		•		
																											Salvage aset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	
1	**3**		**Grounding and Stranding**																															
1	3	1	Due to restricted manoeuvring a vessel navigating near or around AMETS grounds or becomes stranded.	General Navigation	Navigation on Passage	Energy Devices Offshore Installations	All	Fishing Grounds Oil & Gas Installations	Large Vessels Fishing Vessels Military Vessels Other Vessels	Weather Time of Day Circumstances	Mistakes Lapse Slip	Vessel navigating near or around AMETS grounds or becomes stranded. This can happen with large, fishing, military tanker and cargo vessel types. The navigating vessel may be on route to fishing grounds or oil and gas installations nearby. The conditions under which this may occur would be loss of, or the restriction of manoeuvrability, adverse weather conditions or time of day may play a factor as at night rock posing a risk may not be visible. Human error resulting in accidental navigation may contribute to a vessel running aground. Depths where grounding may occur are some distance away from the offshore berth. Important to note the location of Edye Rock just to the NE of the inshore berth which is the biggest hazard to grounding in the area.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Accidental Navigation Emergency Navigation Forced Navigation	Energy Device Design Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage vessels following vessel becoming grounded or stranded; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																											Marking of site on navigation charts		•		•			
																											SAR response planning			•		•		
																											SAR aset provision planning			•		•		
																											Salvage response planning			•		•		
																											Salvage aset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	

Description				Hazard Identification									Risk Assessment														Tolerability	Risk Control							
													Without AMETS				With AMETS													Type			Effect			
Ref			Description of Casual Chain	Accident	Navigation Activities	AMETS Structures	Phase of Development	Structures and Features	Vessel Type	Conditions	Human Activities	Summary	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Navigation Risk Factors	Influences on Cause	Traffic Levels	Circumstances	Influences on Consequences	Non safety Navigation Consequence	Risk Tolerability	Description	Asset	Rule	Good Practice	Prevention	Mitigation	Emergency Response	Summary
2. OTHER NAVIGATION SAFETY																																		
2	**1**		**Foundering and Capsizing**																																
2	1	1	Subsea obstacle(cable, mooring line of either device or buoy) snags fishing equipment, heeling vessel and causing it to founder or capsize.	Other Navigation	Fishing Operations	Subsea Installations	Construction Operation Maintenance Decommissioning	Fishing Grounds	Fishing Vessels	Circumstances Time of Day	Violation Mistakes Lapse Slip	Subsea obstacle such as a cable, mooring line or any AMETS subsea installation, snags fishing equipment, heeling the vessel and causing it to founder or capsize. This is a risk for fishing vessels that may be fishing nearby, especially if a fishing vessel violate safe zones and enter site or the pots/nets drift into the site even if the vessel remains outside it. The presence of trawling grounds close by would contribute to the risk of this occurring. This may happen at all stages of the project after construction and may be as a result of poor visibility. Human error may also be a factor in this risk.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour Other single vessel factors	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Energy Device Design Vessels	Loss of fishing gear, damage to subsea obstacle and possibly obstacle will be set adrift	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; site location to be communicated to fishing organisations and fishing grounds to be reduced to avoid the test area; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of fishing gear snagging on a subsea obstacle; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts in order to inform fishing vessels of site and give them opportunity to plan alternative fishing route; Marking and Lighting of individual structures to make all structures clearly visible during night and day; Define and agree with fishermen a procedure for retrieving fishing gear if the gear ends up within the site which may help prevent interference with subsea equipment within site. SAR response planning to outline procedures in case of emergency; SAR asset provision planning in order to ensure necessary emergency equipment in place; Salvage response planning to outline procedures in place to salvage fishing vessels in the event of foundering or capsizing; Salvage asset provision planning in order to ensure necessary salvage equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Navigation buoys and lights installed in the areas surrounding the site	•			•			
																												Locate site away from trawling ground and other fishing ground identified			•	•			
																												Optimise location, alignment, size and layout.			•	•			
																												Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																												Marking and lighting of individual structures	•			•			
																												Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																												Marking of site on navigation charts		•		•			
																												Define and agree with fishermen a procedure for retrieving fishing gear if the gear ends up within the site			•	•			
																												SAR response planning			•		•		
																												SAR asset provision planning			•		•		
																												Salvage response planning			•		•		
																												Salvage asset provision planning			•		•		
																												Requisitioned Vessels	•					•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	
2	**2**		**Machinery Related Accidents**																																
2	2	1	WEC failure results in floating debris entering the seaways	Other Navigation	All	Energy Devices	Construction Operation Maintenance Decommissioning	Fishing Grounds Oil & Gas Installations	All	Weather Time of Day		Failure of WEC results in floating debris entering the seaways. The floating debris poses a risk to any vessels navigating or operating in the region. This may happen at all stages of the project after construction. This risk applies to all vessel types. The presence of fishing ground and oil and gas installation nearby may increase number of vessels in area. Collision with debris may be caused by; poor weather, poor light or impossibility of changing vessel route to avoid it.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site			Intentional Navigation	Energy Device Design	Damage to energy device machinery.	Broadly Acceptable	Locate site away from main vessel routes established				•	•		Site located away from main vessel routes identified to reduce chance of vessel encountering floating debris from site; Ensure WEC and buoy integrity reduce need for maintenance and therefore reduce chance of failure and parts floating away from device; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Ensure wave energy device integrity reducing need for maintenance				•	•		
																												SAR response planning				•		•	
																												SAR asset provision planning				•		•	
																												Salvage response planning				•		•	
																												Salvage asset provision planning				•		•	
																												Requisitioned Vessels	•					•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	
2	2	2	WEC failure results in a failure of WEC navigation aids (e.g. lighting) resulting in non detection of AMETS and increase risk of powered contact	Other Navigation	All	Energy Devices Offshore Installations	Construction Operation Maintenance Decommissioning		All	Circumstances		WEC device control failure leading to detection failure of AMETS. This could in turn result in other risks mention above such as contact/collision etc.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Interrelations between Vessels Navigator Behaviour	Aids to Navigation Interference	Current	Accidental Navigation	Vessels	Structural damage to vessels; Potential Pollution; Loss of revenue for vessel operators	Broadly Acceptable	Locate site away from main vessel routes established				•	•		Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; navigation aids provided on all individual structures including buoys; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Marking and lighting of individual structures	•			•			
																												Optimise location, alignment, size and layout.				•	•		
																												SAR response planning				•		•	
																												SAR asset provision planning				•		•	
																												Requisitioned Vessels	•					•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	
2	**3**		**Accidents to Personnel**																																
2	3	1	Accidents caused by Transfer to/from servicing vessel (or helicopter) to a WEC or another service vessel requiring SAR and/or emergency response	Other Navigation Safety Risks	Other Marine Operations close to or within Test	Energy Devices	Construction Operation Maintenance Decommissioning		All	Weather Time of Day Circumstances	Mistakes Slip	Accident to personnel transferring from vessel to device requires SAR and/or emergency response. SAR/Emergency vessels and personnel may pose risk to other vessels in the area. This may occur at any stage of the project after construction. The accident may be caused by; poor weather, poor light, communication failure between parties involved in transfer, vessel manoeuvring restrictions, accidental human error.	N/A	N/A	N/A	N/A	Reasonably Probable	Insignificant	3	Minor	Site Traffic Interrelations between Vessels Navigator Behaviour	Interference Aids to Navigation			Energy Device Design Vessels	Loss of earnings to personnel due to injuries.	Tolerable with Monitoring	Optimise location, alignment, size and layout.				•	•		Location, alignment, size and layout optimised to ensure navigation easy within AMETS site and to ensure appropriate room for vessels to manoeuvre during construction, maintenance and decommissioning procedures; Marking and Lighting of individual structures to make all structures clearly visible during night and day; Ensure wave energy device integrity reducing need for maintenance thus reduce servicing vessel activity at the test site; Personnel protective equipment compulsory for all personnel on site to ensure safety; Site personnel trained in fire fighting, first aid and offshore survival so can assist in event of accident; Use certified equipment in carrying out the transfer; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Marking and lighting of individual structures	•			•			
																												Ensure wave energy device integrity reducing need for maintenance				•	•		
																												Personnel protective equipment compulsary		•			•		
																												Site personnel training in firefighting, first aid and offshore survival				•	•		
																												Adverse weather working conditions policy				•	•		
																												Use certified/rated equipment		•			•		
																												SAR response planning				•		•	
																												SAR asset provision planning				•		•	
																												Requisitioned Vessels	•					•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	
2	3	2	Accidents (fire, explosion, etc..) onboard a device requires emergency rescue of servicing personnel.	Other Navigation Safety Risks Search and Rescue	Other Marine Operations close to or within Test	Energy Devices	Construction Operation Maintenance Decommissioning		All		Violation Mistakes Lapse Slip	Accidents onboard a device require emergency rescue of servicing personnel. SARvessels and personnel may pose risk to other vessels in the area. Examples of accidents that might occur are fire or explosion on device during construction or maintenance. This may occur at any stage of the project after construction. Unpermitted action or human error may have contributed to fire.	N/A	N/A	N/A	N/A	Extremely Remote	Insignificant	1	Minor	Site Traffic Interrelations between Vessels Navigator Behaviour Other single vessel factors	Interference Aids to Navigation		Emergency Navigation	Energy Device Design Emergency Response	Loss of earnings to personnel due to injuries.	Broadly Acceptable	Personnel protective equipment compulsary		•			•		Personnel protective equipment compulsory for all personnel on site to ensure safety; Site personnel trained in fire fighting, first aid and offshore survival so can assist in event of accident; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Site personnel training in firefighting, first aid and offshore survival				•	•		
																												Adverse weather working conditions policy				•	•		
																												SAR response planning				•		•	
																												SAR asset provision planning				•		•	
																												Requisitioned Vessels	•					•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	
2	3	3	Person in water (unaided, in floatation device, life raft or life boat) requires rescue	Other Navigation Search and Rescue	All		All		All	Weather Time of Day	Violation Mistakes Lapse Slip	Personnel in water requires rescue. SAR vessels and personnel may pose risk to other vessels in the area. Person may have fallen from any type of vessel navigating in the area into water. Most likely during construction, maintenance or decommissioning of site when person working on site may fall overboard but can occur at all stages of the project. Poor weather, poor light, violation or human error may have contributed to person ending up in water	Remote	Insignificant	2	Minor	Reasonably Probable	Insignificant	3	Minor	Site Traffic Interrelations between Vessels Navigator Behaviour Other single vessel factors	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Search and Rescue Emergency Response	Loss of earnings to personnel due to injuries.	Tolerable with Monitoring	Personnel protective equipment compulsary		•			•		Personnel protective equipment compulsory for all personnel on site to ensure safety; Site personnel trained in fire fighting, first aid and offshore survival so can assist in event of accident; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of accidents as a result of bad weather; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																												Site personnel training in firefighting, first aid and offshore survival				•	•		
																												Adverse weather working conditions policy				•	•		
																												SAR response planning				•		•	
																												SAR asset provision planning				•		•	
																												SAR - Lifeboats	•					•	
																												SAR Helicopter	•					•	

Description				Hazard Identification								Risk Assessment															Tolerability	Risk Control							
												Without AMETS				With AMETS													Type		Effect				
Ref			Description of Casual Chain	Accident	Navigation Activities	AMETS Structures	Phase of Development	Structures and Features	Vessel Type	Conditions	Human Activities	Summary	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Frequency	"Typical" Consequence	Criticality	"Worst Credible" Consequence	Navigation Risk Factors	Influences on Cause	Traffic Levels	Circumstances	Influences on Consequences	Non safety Navigation Consequence	Risk Tolerability	Description	Asset	Rule	Good Practice	Prevention	Mitigation	Emergency Response	Summary
2	**4**		**Electrocution**																															
2	4	1	Vessel hits WEC sufficiently hard to pierce and breach cable insulation	Other Navigation	All	Energy Devices	Construction Operation Maintenance Decommissioning		All	Weather Time of Day Circumstances	Violation Mistakes Lapse Slip	Vessel hits energy device structure sufficiently hard to pierce and breach cable insulation. Vessels are prohibited to navigate within the AMETS. Construction and maintenance vessels may operate within the site and there is also the possibility of vessels violating the safe zone and entering the site to retrieve fishing gear for instance. This risk applies to all vessel types. The collision may be caused by; poor weather, poor light, AIS/radar problems, vessel manoeuvring restrictions due to presence of AMETS, accidental human error resulting in accidental navigation, trying to avoid obstacles such as the energy devices, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic Navigator Behaviour Other single vessel factors	Aids to Navigation Interference	Current	Accidental Navigation Emergency Navigation Forced Navigation	Energy Device Design Vessels Emergency Response	Structural damage to vessels; Loss of revenue for vessel operator; Damage to energy device.	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety and reduce chance of vessel coming into contact with WEC; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of contact; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; Guard vessel during construction/decommissioning to protect vessels and to alert navigating vessel of operations; Adverse weather working conditions policy to prevent work being carried out in inappropriate weather and to reduce likelihood of servicing vessels hitting WECs as a result of bad weather; Marking and Lighting of individual structures to make all structures clearly visible during night and day; Position monitoring of WECs and buoys to ensure position stationary and not drifting; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Marking and lighting of individual structures	•			•			
																											Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																											Position monitoring of WECs and buoys			•	•			
																											Marking of site on navigation charts		•		•			
																											Guard vessel during construction/decommissioning activities			•	•			
																											Adverse weather working conditions policy			•	•			
																											SAR response planning			•		•		
																											SAR asset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	
2	4	2	Anchoring vessel drags up export cable and shorts cable to the anchor	Other Navigation	Anchoring	Cable	Construction Operation Maintenance Decommissioning		All	Weather Time of Day	Violation Mistakes Lapse Slip	Anchoring vessel drags up export cable and shorts cable to the anchor. Anchoring of vessels in the area within or near AMETS is rare, perhaps in the case of an emergency a vessel may need to anchor. This risk applies to all vessel types. Vessel may have decided to anchor because of; poor weather, poor light. Human activities may have contributed to the accident also including; accidental human error resulting in accidental navigation in area of cable, unpermitted action in the case of navigating vessel travelling through the test site.	N/A	N/A	N/A	N/A	Extremely Remote	Minor	2	Major	Site Traffic	Aids to Navigation Interference	Current	Accidental Navigation Forced Navigation	Vessels	Loss of earnings to personnel due to injuries.	Broadly Acceptable	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Site located away from main vessel routes to reduce the impact on navigation of AMETS and reduce likelihood of vessels in vicinity; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily avoided and navigatable around; Safety zones of appropriate configuration, extent and application to specified vessels at AMETS in place to avoid navigation of vessels in dangerous areas and to reduce chance of vessel anchoring above cable; Promulgation of information and warning through notices to mariners and other appropriate media to heighten mariner awareness of site; Marking of site on navigation charts inorder to inform vessels of site and give them opportunity to plan alternative route; SAR response planning to outline procedures in case of emergency; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Locate site away from main vessel routes established			•	•			
																											Safety zones of appropriate configuration, extent and application to specified vessels at AMETS			•	•			
																											Optimise location, alignment, size and layout.			•	•			
																											Promulgation of information and warning through notices to mariners and other appropriate media.		•	•	•			
																											Marking of site on navigation charts		•		•			
																											SAR response planning			•		•		
																											SAR asset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	
3. SEARCH AND RESCUE																																		
3	**1**		**Overall**																															
3	1	1	Presence of the AMETS increases the risk of an accident (e.g. collision, contact, stranding or grounding) requiring search and rescue and also may hinder search and rescue.	Search and Rescue	All	Energy Devices Offshore Installations Cable Subsea Installations	All	Oil & Gas Installations Fishing Grounds	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	Presence of the AMETS increases the frequency of an accident (e.g. collision, contact, stranding or grounding) and also may hinder search and rescue. Presence of the site may prevent SAR vessels taking the shortest and most direct route to accident. WEC may also pose a threat if accident or person needs rescuing within the test site.	N/A	N/A	N/A	N/A	Remote	Minor	3	Major	Site Traffic Interrelations between Vessels	Aids to Navigation Interference	Current	Emergency Navigation	Energy Device Design Search and Rescue		Tolerable with Monitoring	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily navigatable in the event of search and rescue operation; Marking of site on navigation charts inorder to inform SAR vessels of site and give them opportunity to plan alternative routes to take in event of emergency; Marking and lighting of individual structures to make all structures clearly visible during night and day if a SAR operation requires SAR personnel to enter site; SAR response planning to outline procedures in case of emergency; SAR training; SAR asset provision planning inorder to ensure necessary emergency equipment in place; Means to requisition vessel in event of emergency; SAR lifeboat available in area; SAR Helicopter available in area.
																											Optimise location, alignment, size and layout.			•	•			
																											Marking and lighting of individual structures	•			•			
																											Marking of site on navigation charts		•		•			
																											SAR response planning			•		•		
																											SAR asset provision planning			•		•		
																											Requisitioned Vessels	•					•	
																											SAR - Lifeboats	•					•	
																											SAR Helicopter	•					•	
4. EMERGENCY RESPONSE																																		
4	**1**		**Overall**																															
4	1	1	Presence of AMETS increases need for emergency response from Foundering, Capsizing, Collision, Grounding or Stranding and also may hinder ability to provide emergency response.	Emergency Response	All	Energy Devices Offshore Installations	All	Oil & Gas Installations Fishing Grounds	All	Weather Time of Day Circumstances Electronics	Violation Mistakes Lapse Slip	Presence of the AMETS increases the frequency of an accident (e.g. collision, contact, stranding or grounding) and also may hinder search and rescue. Presence of the site may prevent emergency vessels taking the shortest and most direct route to accident. AMETS may also pose a threat if emergency occurs within AMETS.	N/A	N/A	N/A	N/A	Remote	Minor	3	Major	Site Traffic Interrelations between Vessels Navigator Behaviour Other single vessel factors	Aids to Navigation Interference	Current	Intentional Navigation Accidental Navigation Emergency Navigation Forced Navigation	Energy Device Design Vessels Search and Rescue Emergency Response		Tolerable with Monitoring	Navigation buoys and lights installed in the areas surrounding the site	•			•			Navigation buoys and lights installed in the area surrounding the site to increase navigation safety; Location, alignment, size and layout optimised to reduce size of area occupied by berths and to ensure areas easily navigatable in the event of emergency operation; Marking of site on navigation charts inorder to inform emergency vessels of site and give them opportunity to plan alternative routes to take in event of emergency; Marking and Lighting of individual structures to make all structures clearly visible during night and day if a emergency operation requires emergency personnel to enter site; Salvage response planning to outline procedures in place in event of emergency; Salvage asset provision planning inorder to ensure necessary salvage equipment in place; Emergency training for different possible emergency events; Means to requisition vessel in event of emergency;
																											Optimise location, alignment, size and layout.			•	•			
																											Marking and lighting of individual structures	•			•			
																											Marking of site on navigation charts		•		•			
																											Salvage response planning			•		•		
																											Salvage asset provision planning			•		•		
																											Requisitioned Vessels	•					•	