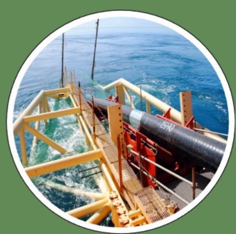
GREENLINK
MARINE NATURA IMPACT STATEMENT

P1975_R4698_RevF2_NIS
July 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR

CONTENTS

LIST OF TABLES AND FIGURES

Tables

Figures

GLOSSARY AND ABBREVIATIONS

AA
Appropriate Assessment

ADD
Acoustic Deterrent Device

Birds Directive
EC Council Directive 2009/147/EC on the conservation of wild birds

B Field
Magnetic field

CBRA
Cable Burial Risk Assessment

CEMP
Construction Environmental Management Plan

CL
Conservation Limit

CLB
Cable Lay Barge

CLV
Cable Lay Vessel

DAHG
Department of Arts, Heritage and the Gaeltacht

DEHLG
Department of the Environment, Heritage and Local Government

DP
Dynamic Positioning

EC
European Commission

EIA
Environmental Impact Assessment

EIAR
Environmental Impact Assessment Report

EMF
Electromagnetic Fields

EPA
Environmental Protection Agency

EPS
European Protected Species

EU
European Union

EUNIS
European Nature Information System

FCS
Favourable Conservation Status

GIL
Greenlink Interconnector Ltd

Habitats Directive
EC Directive 92/43/EC on the conservation of natural habitats and of wild fauna and flora

HDD
Horizontal Directional Drilling

HRA
Habitats Regulations Assessment

HVDC
High Voltage Direct Current

iE
Induced Electric (Field)

IROPI
Imperative Reasons of Overriding Public Interest

JUB
Jack-Up Barge

KP
Kilometre Point

MHWS
Mean High-Water Springs

MMO
Marine Mammal Observer

MU
Management Unit

NIS
Natura Impact Statement

NPWS
National Parks and Wildlife Service

OSPAR
Oslo and Paris

PAM
Passive Acoustic Monitoring

PCE
Potential Cumulative Effect

PCI
Project of Common Interest

PTS
Permanent Threshold Shift

S.I
Statutory Instrument

SAC
Special Area of Conservation

SOPEP
Shipboard Oil Pollution Emergency Plans

SPA
Special Protection Area

SPL
Sound Pressure Level

SPM
Suspended Particulate Matter

TEN-E
Trans-European Network for Energy

TJP
Transition Join Pit

TTS
Temporary Threshold Shift

UXO
Unexploded Ordnance

1. Introduction

1.1 Project Background

Greenlink Interconnector Limited (GIL) is proposing to develop an electricity interconnector (Greenlink) linking the existing electricity grids in Ireland and Great Britain. The Greenlink project will consist of two converter stations, one close to the existing substation at Great Island in County Wexford (Ireland) and one close to the existing substation at Pembroke in Pembrokeshire (Wales). The converter stations will be connected by underground cables (onshore) and subsea cables (offshore). The Greenlink route is shown in Figure 1-2 (Drawing P1975-LOC-001).

Greenlink is designated as a European Union Project of Common Interest (PCI), project number 1.9.1, under the provisions of European Union Regulation No. 347/2013 on guidelines for Trans-European Network for Energy (TEN-E Regulations) and has successfully applied for funding under the Connecting Europe Facility.

This Natura Impact Statement (NIS) covers the Irish Marine components of Greenlink from mean high-water springs (MHWS) at the Irish landfall at Baginbun Beach, Co. Wexford to the 12nm limit. This is defined as the Proposed Development and comprises:

- Two high voltage direct current (HVDC) electricity power cables;
- A smaller fibre-optic cable for control and communication purposes;
- All associated works required to install, test, commission and complete the aforementioned cables; and
- All associated works required to operate, maintain, repair and decommission the aforementioned cables, including five repair events over the 40 year lifetime of Greenlink.

The location of the Proposed Development is illustrated in Figure 1-3 (Drawing P1975-CORR-002).

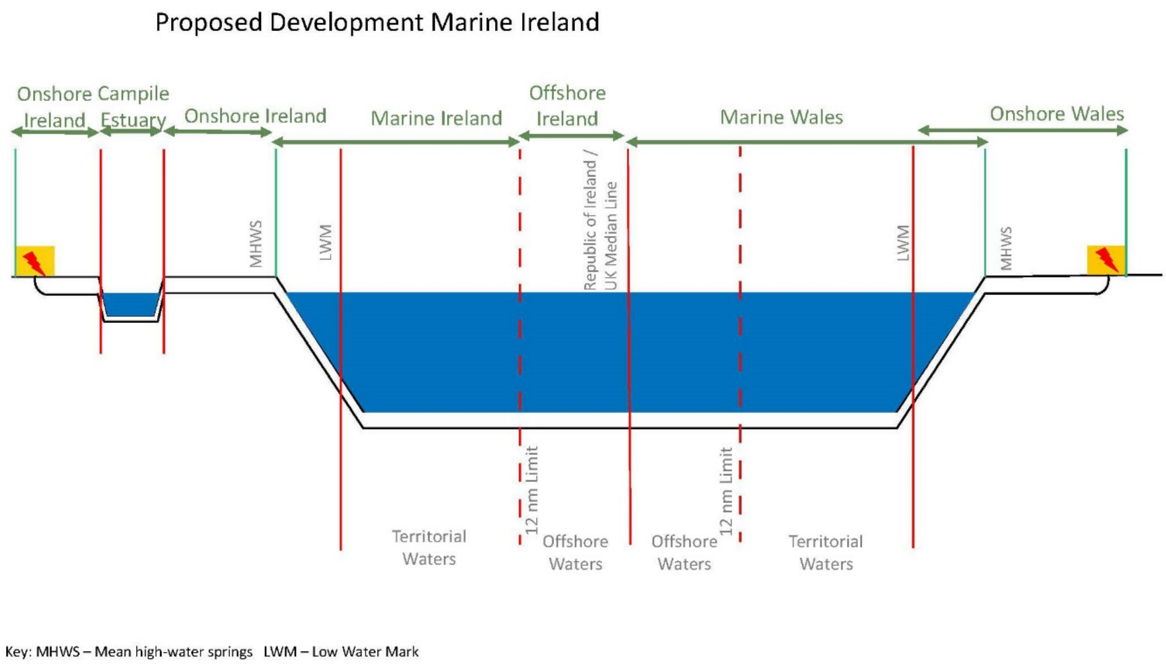
This document also provides information on the Campile Estuary component of Greenlink (where the onshore cable route crosses the foreshore at the River Campile), and the Irish Offshore components of Greenlink from the 12nm territorial limit to the Ireland/UK median line.

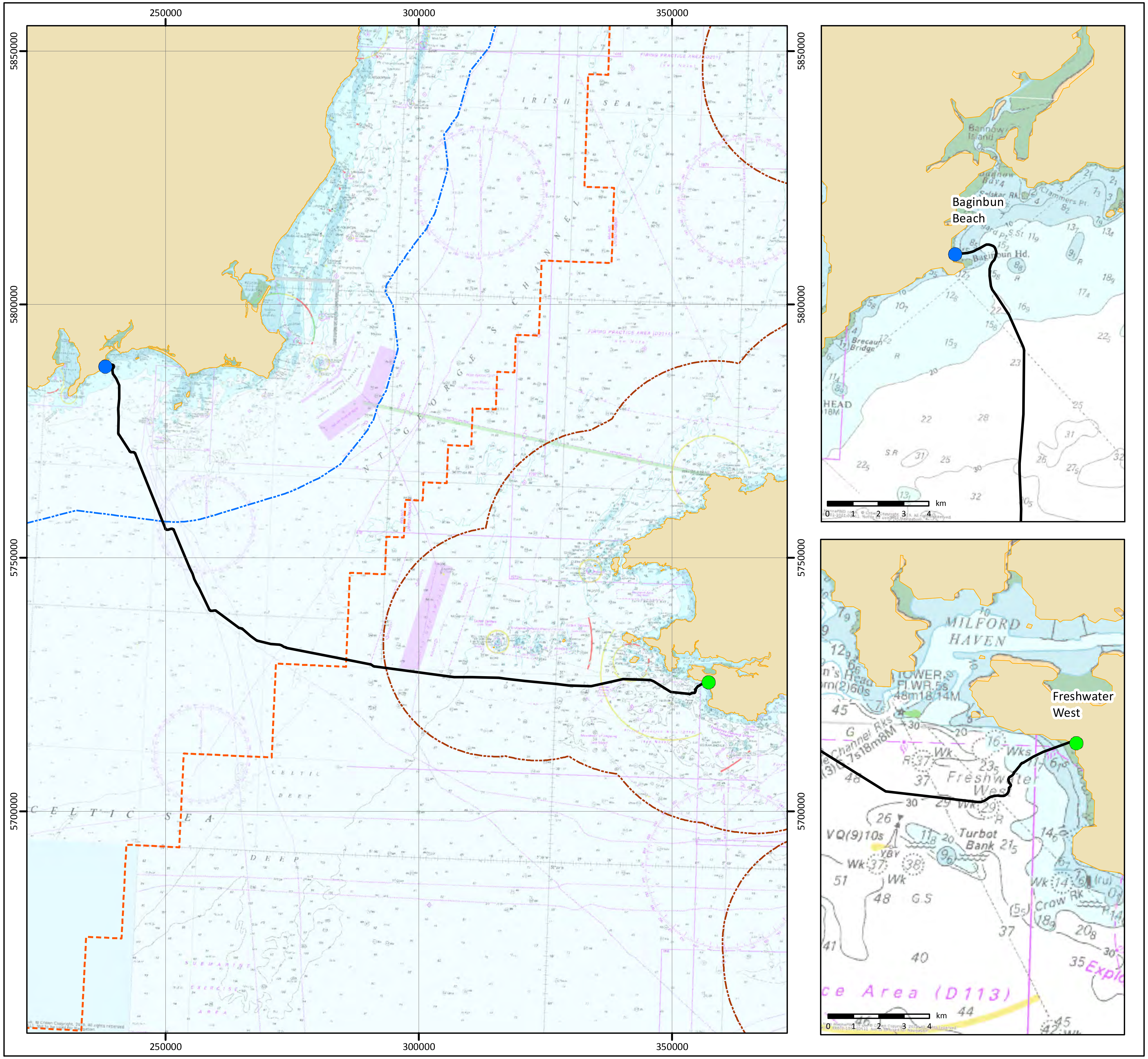
The Proposed Development crosses the Hook Head SAC (Site Code: IE0000764) and the Campile Estuary component crosses the River Barrow and River Nore SAC (Site Code: IE0002162). As the project is not directly connected with or necessary to the management of the two Natura 2000 sites it is regarded as necessary that the Proposed Development and Campile Estuary components should be subject to the AA process.

Separate NISs / Habitats Regulations Assessments (HRAs) will be prepared which cover individually the Welsh Onshore; the Irish Onshore; the Welsh Marine (the submarine route from the Ireland/UK median line to MHWS at the Welsh landfall at

Freshwater West, Pembrokeshire); and the Irish Marine (the submarine route from MHWS at the Irish landfall at Baginbun Bay, County Wexford to the 12nm limit) and Irish Offshore (the submarine route from the 12nm limit to the Ireland/UK median line). These include a full cumulative effects assessment of all five components of the project. As the NISs / HRAs are submitted they will be available online at www.greenlink.ie. The boundaries of the individual components described are shown in Figure 1-1.

Figure 1-1 Components of Greenlink





GREENLINK INTERCONNECTOR

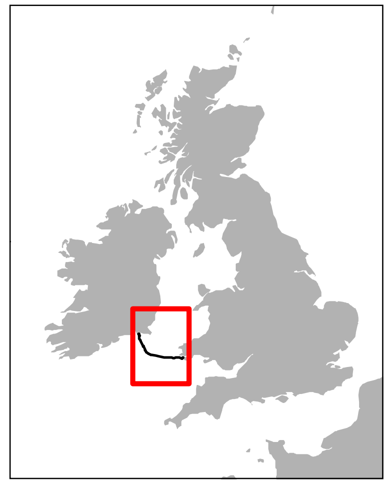
ROUTE OVERVIEW

Drawing No: P1975-LOC-001 | **A**

Legend

Landfall
- Baginbun Beach
- Freshwater West
- Greenlink Route Centreline (Indicative)

Administrative Boundaries
- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line



NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 08:45:37
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; GEBCO; MarineFind; Greenlink
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-001.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Greenlink

Co-financed by the European Union
Connecting Europe Facility

intertek

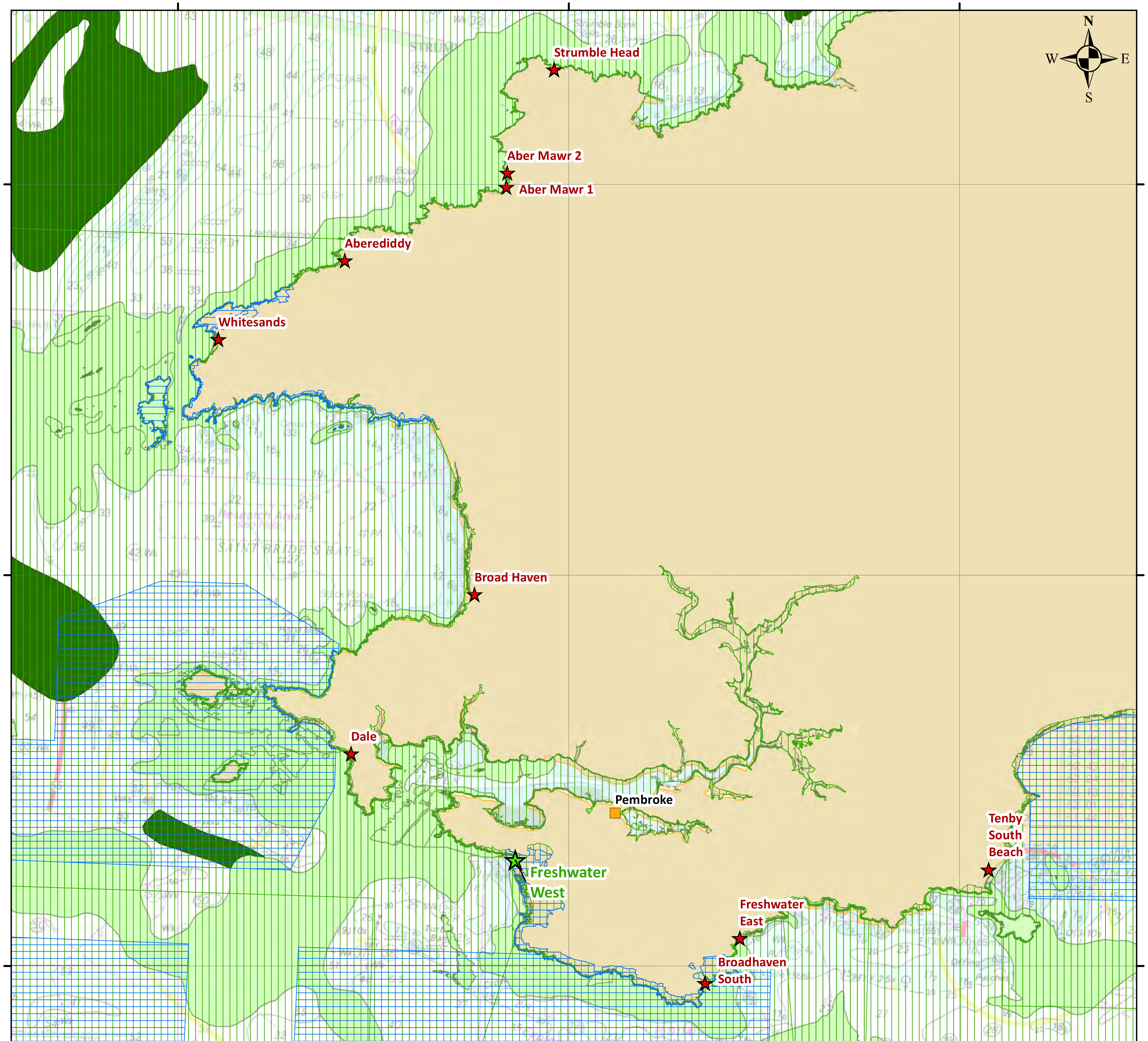
km
0 10 20 30 40

GREENLINK INTERCONNECTOR

ROUTE OVERVIEW

UK Landfall Options

Drawing No: P1975-LOC-002 | A



Legend

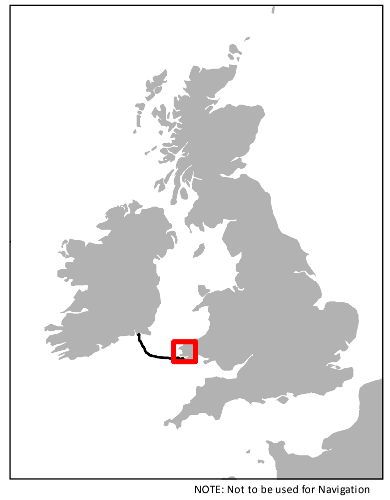
- Landfall Selected
- Landfall Considered
- Power Station

Protected Sites

- SAC
- SPA

Potential Reef

- Bedrock
- Stony



Date	Monday, April 8, 2019 08:48:09
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	CDA; GEBCO; UKHO; JNCC; MarineFind
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-002.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 2 4 6 8 km

1.2 Legislative context

The Birds Directive (2009/147/EC) and the Habitats Directive (92/42/EEC) require European Union (EU) Member States to establish a network of sites of highest biodiversity importance for rare and threatened habitats and species across the EU. This network of sites is known as the Natura 2000 network. The network comprises Special Areas of Conservation (SACs) designated under the Habitats Directive, and Special Protection Areas (SPAs) designated under the Birds Directive. SPAs and SACs are designated by the individual member states. Sites which have been submitted to the European Union but which have not formally been adopted e.g. candidate SACs, proposed SPAs and Sites of Community Importance (SCI) also form part of the network and are treated as if fully designated.

A key requirement of the Habitats Directive is that the effects of any plan or project, alone, or in combination with other plans or projects, on the Natura 2000 site network, should be assessed before any decision is made to allow that plan or project to proceed. This process is known as Appropriate Assessment (AA). Each plan or project considered for approval, must take into consideration the possible effects it may have in combination with other plans and projects when going through the AA process.

The obligation to undertake AA derives from Article 6(3) and 6(4) of the Habitats Directive.

Article 6(3) of the Habitats Directive states that:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public."

This provision is transposed into Irish law in respect of this foreshore application by Part 5 of the European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011), (as amended). Regulation 42(1) of the 2011 Regulations provides for screening for Appropriate Assessment as follows:

"A screening for Appropriate Assessment of a plan or project for which an application for consent is received, or which a public authority wishes to undertake or adopt, and which is not directly connected with or necessary to the management of the site as a European Site, shall be carried out by the public authority to assess, in view of best scientific knowledge and in view of the conservation objectives of the site, if that plan or project, individually or in combination with other plans or projects is likely to have a significant effect on the European site."

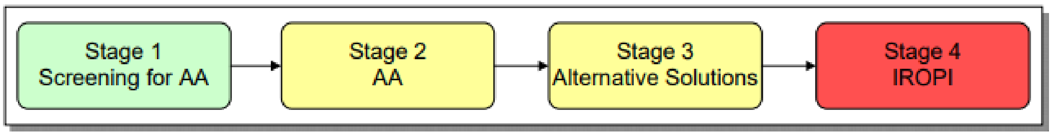
Regulations 42(6) and 42(7) provide for the outcome of screening for Appropriate Assessment as follows:

"The public authority shall determine that an Appropriate Assessment of a plan or project is required where the plan or project is not directly connected with or necessary to the management of the site as a European Site and if it cannot be excluded, on the basis of objective scientific information following screening under this Regulation, that the plan or project, individually or in combination with other plans or projects, will have a significant effect on a European site. Alternatively, a public authority shall determine that an Appropriate Assessment of a plan or project is not required where: the plan or project is not directly connected with or necessary to the management of the site as a European Site and if it can be excluded on the basis of objective scientific information following screening under this Regulation, that the plan or project, individually or in combination with other plans or projects, will have a significant effect on a European site."

Pursuant to the Foreshore Acts 1933 – 2011 (the "Foreshore Acts") this NIS will be submitted to the Foreshore Unit to support the application for a Foreshore Licence in respect of the Proposed Development.

The European Commission's methodological guidance (EC 2001) outlines a four-stage approach to the AA process, where the outcome at each successive stage determines whether a further stage in the process is required. The results at each step must be documented so there is transparency of the decisions made. The four stages are shown in Figure 1-4 and described below.

Figure 1-4 Stages of AA



1.2.2 Stage 1 - Screening for Appropriate Assessment

Stage 1 of the AA process is referred to as screening for Appropriate Assessment and identifies whether the proposed plan or project, either on its own or in combination with other plans or projects, would be "likely to have a significant effect" upon any European site. A likely effect is one that cannot be ruled out on the basis of objective information. The test is a 'possibility' of effects rather than a 'certainty' of effects. The test of significance is whether a plan or project could undermine the site's conservation objectives.

1.2.3 Stage 2 - Appropriate Assessment

If effects are considered likely to be significant, potentially significant or uncertain, or if the screening process becomes overly complicated, the process must proceed to Stage 2: Appropriate Assessment, with the preparation of a Natura Impact

Statement to inform the Appropriate Assessment that is to be conducted by the competent authority.

The European Court of Justice has also made a relevant ruling on what should be contained within an Appropriate Assessment4:

"[The Appropriate Assessment] cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned".

1.2.4 Stage 3 – Alternative solutions

This stage examines any alternative solutions or options that could enable the plan or project to proceed without adverse effects on the integrity of a Natura 2000 site. Demonstrating that all reasonable alternatives have been considered and assessed, and that the least damaging option has been selected, is necessary to progress to Stage 4.

1.2.5 Stage 4 - Imperative Reasons of Overriding Public Interest (IROPI)/Derogation

Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a Natura 2000 site to proceed in cases where it has been established that no less damaging alternative solution exists.

The extra protection measures for Annex I priority habitats come into effect when making the IROPI case. IROPI reasons that may be raised for sites hosting priority habitats are those relating to human health, public safety or beneficial consequences of primary importance to the environment. In the case of other IROPI for Annex I priority habitats, the opinion of the European Commission is necessary and should be included in the AA. Compensatory measures must be proposed and assessed. The European Commission must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister for Housing, Planning, Community and Local Government.

1.3 Aim of this Report

The aim of this report is to inform the AA process in determining whether the Proposed Development and Campile Estuary component, both alone and in combination with other plans or projects, are likely to have a significant effect on any Natura 2000 site. The effects of the Proposed Development on the Natura 2000 site are considered in the context of the sites conservation objectives and specifically on the habitats and species for which the sites have been designated. If significant effects are likely then effects are examined to determine if they will either alone, or in combination with other plans or projects effect the integrity of the Natura 2000 site.

The NIS provides a description of the Proposed Development (Section 2); the receiving environment (Section 3); and the potential pressures that could arise from the planned activities on the receiving environment (Section 4). It determines it there is any connectivity between the Proposed Development and any Natura 2000 sites (Stage 1 AA Screening, Section 4) and considers the potential for adverse effects on the conservation objectives and qualifying interests within the affected Natura 2000 site(s) (Stage 2 Natura Impact Statement, Section 5). It concludes, in Section 5, with a statement for each Natura 2000 site as to whether the integrity of the site will be adversely affected and if necessary proposes mitigation to reduce the significance of effects.

This report has been prepared in accordance with current guidance:

- Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (European Commission, EC 2018a);
- Guidance on Energy Transmission Infrastructure and EU nature legislation, (EC 2018b);
- Marine Natura Impact Statements in Irish Special Areas of Conservation – A Working Document (DAHG 2012);
- Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities (Department of Environment, Heritage and Local Government 2010);
- EU Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC (EC 2007); and
- Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (EC 2001).

1.4 Consultation

Consultation has been undertaken with key statutory consultees and stakeholders and the public during key stages of project development. GIL has consulted with the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht (DAHG), throughout project design (cable routeing) to identify the ecological constraints and sensitivities of the habitats and species in the area. A scoping opinion from NPWS was received on the broader Environmental Impact Assessment which has informed the NIS.

2. Description of the Project

2.1 Overview

Greenlink is a proposed subsea and underground electricity interconnector between the existing electricity grids in the Republic of Ireland and Great Britain with a nominal capacity of 500 megawatts. Greenlink comprises subsea and underground cables and associated converter stations to connect EirGrid's Great Island transmission substation in County Wexford (Ireland) and National Grid's Pembroke transmission substation in Pembrokeshire (Wales). The power will be able to flow in either direction, depending on supply and demand in each country.

The converter stations will be connected by two HVDC cables under the Irish Sea. A fibre optic cable will also be laid for control and communication purposes.

The subsea cable system will be joined to the corresponding land cable system in a transition joint pit (TJP) located above MHWS, and therefore does not form part of the Proposed Development (the subject of this NIS). However, as Greenlink is a linear project, intra-project effects from activities associated with the land cable system have been taken into consideration.

The proposed landfall site is Baginbun Beach, Co.Wexford. The total length of the Greenlink marine cables is approximately 159km of which approximately 36km forms the Proposed Development in Irish territorial waters and 50km is within Irish Offshore waters.

2.2 Development of the Project

The configuration of any interconnector project is influenced by the location of the existing network infrastructure, its ability to accommodate the required connection capacity, any requirement for network reinforcements, and other factors such as environmental constraints.

A full description of the alternatives considered and route development is provided in the Greenlink Marine EIAR – Ireland, Chapter 3. For ease of reference this chapter has been provided as Appendix A of this NIS. The following sections summarise the key points.

2.2.1 Connection point selection

2.2.1.1 Irish and GB Transmission Networks

The importance of Greenlink, linking the Irish and GB Transmission Networks, is recognised through its PCI status which makes it one of Europe's most important energy infrastructure projects and granting it the "highest national significance" possible. The requirement and need for Greenlink has been reinforced by Ofgem (GB) and CRU (Ireland) via the completion of a Cost Benefit Analysis which demonstrates that Greenlink offers economic benefit to consumers in both jurisdictions.

On the 17 June 2019 the Irish Government published its Climate Action Plan (CAP) which set out a cross sector suite of objectives and actions aimed at reducing Ireland emissions (DCCAE 2019). The CAP emphasis the role of new interconnection to *'balance its significant renewables potential with security of electricity supply and develop long term ambitions to export is offshore renewable resources'*. Therefore Greenlink will contribute to reducing Irelands carbon emissions.

2.2.1.2 Transmission Network Substation Connection Options

The configuration of any interconnector project is influenced by the location of the existing network infrastructure, its ability to accommodate the required connection capacity, any requirement for network reinforcements, and other factors such as environmental constraints. A review of these factors was undertaken for both the Irish and GB Transmission Networks by EirGrid and National Grid Electricity System Operator, respectively.

2.2.1.3 Irish Transmission Network

A review of suitable points of connection was undertaken in Ireland. Connection locations on the east of Ireland were assessed. Following a network review the most suitable location on the east of the Irish Transmission Network was found to be the Great Island Substation in County Wexford.

2.2.1.4 GB Transmission Network

The National Grid completed a Connections and Infrastructure Options Note process to assess potential grid connection locations within the GB Transmission Network. Connection locations to the west of the GB Transmission Network were assessed.

The Connections and Infrastructure Options Note process is a defined procedure which is used for all large electricity users and generators seeking connection to the GB electricity network. This process considers both the cost benefit of different connection options and the engineering limitations of the existing network.

Eight substations were initially considered as potential connection points. National Grid Electricity System Operator then completed a Cost Benefit Analysis for the four remaining options (Alverdiscott 400kV, Swansea North 400kV, Pembroke 400kV and Pentir 400kV). Table 2-1 summarises route distances between Ireland and the four options.

Table 2-1 Summary of project distances

	Distance (km)		
Site	Onshore	Offshore	Total Distance
Alverdiscott 400kV	38	222 (direct)	260
Pembroke 400kV	36	159 (known constraints included)	195
Swansea North 400kV	59	207 (direct)	266
Pentir 400kV	49	220 (direct)	269

Note: It was acknowledged that length of direct offshore routes is likely to increase by 10 to 20% as constraints become known and therefore costs would increase accordingly.

After completing the Connections and Infrastructure Options Note and Cost Benefit Analysis, National Grid Electricity System Operator determined the most economical connection point to be Pembroke 400kV substation, requiring only a busbar extension to provide a connection point for Greenlink. National Grid Electricity System Operator also concluded that the site facilitates the connection from other points of view (environmental, consenting etc) and as such is the preferred connection point.

2.2.2 Landfall selection

Following identification of Great Island substation as the connection point, GIL commissioned a number of studies to determine a suitable landfall site. A decision was taken early on to discount a route up the River Barrow estuary directly to Great Island for the following reasons:

- The River Barrow Estuary adjacent to the Great Island substation forms part of the River Barrow and River Nore Special Area of Conservation, and important fish breeding (spawning) area.
- Although there is a navigation channel through the estuary to the Port of Waterford in which water depths reach 10m, water depths across most of the estuary are typically 5m or less. Constraints in this area include:
  - Navigation channels, dredged channels and designated anchor zones which are avoided where possible when routeing a cable due to the risk posed to the cable from dredging and accidental anchoring.
  - Long stretches of shallow water depths are technically difficult from a cable installation perspective, requiring very slow moving anchored barges. This can lead to increased levels of disruption (e.g. to fishing and commercial shipping), habitat disturbance and higher costs.

Ten potentially suitable landfall locations were identified in County Wexford, which were visited and assessed using a range environmental, technical and economic criteria. Criteria assessed included vessel access, beach composition, amenity impact, environmental constraints (e.g. presence of protected sites), exposure, coastal erosion, access to beach, cable engineering and protection requirements, obstructions and existing infrastructure. Shown on Figure 2-1 the ten sites were Rathmoylan Cove, Boyce’s Bay, Sandeel Bay, Carnivan Bay, Baginbun Beach, Dollar Bay, Booley Bay, Newtown Beach, Bannow Beach and Cullenstown Beach.

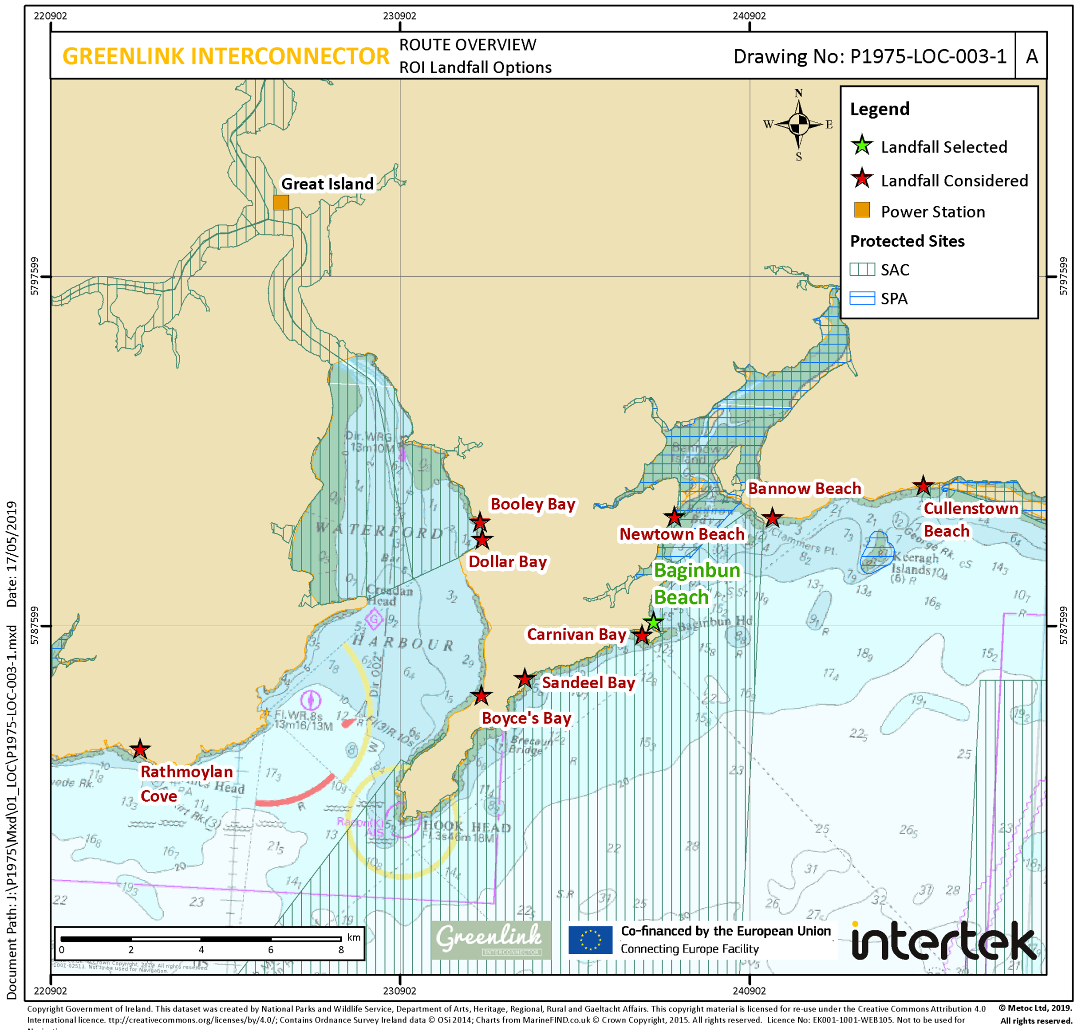
Of the ten potential sites, six were discounted as less preferential on environmental and technical grounds. Four ‘preferred’ landfall options were recommended for further investigation; Baginbun Beach, Booley Bay, Boyce's Bay and Sandeel Bay.

Booley Bay was discounted due to the level of dredging at Duncannon, putting both the cable and the dredging at risk. Sandeel Bay was disqualified due to costs and environmental considerations associated with rocky reef within the Hook Head SAC.

Baginbun Beach was selected as the preferred Irish landfall location as it yielded the shortest overall cable route length and meet the requirements the other landfall options fall short on. However selection as the preferred option was dependent on the results of the cable route survey. The survey needed to demonstrate that the submarine cable route could be installed without significantly affecting the integrity of the Hook Head SAC. Boyce's Bay was selected as an alternative option if the cable route survey indicated Baginbun Beach was not a feasible option.

Following the cable route survey, Baginbun Beach was selected as the preferred landfall. For the landfall selection process please refer to the Greenlink Marine EIAR – Technical Appendix L.

Figure 2-1 Landfall options



2.3 Cable route development

Route development has been an iterative process involving cycles of consultation, refinement and survey. The submarine cable route has been designed to avoid or reduce environmental effects while also accommodating other factors.

A full description of the alternatives considered and route development is provided in the Greenlink Marine EIAR – Ireland, Chapter 3 (Appendix A of this NIS). Below is a summary of the key points.

In Ireland, the main objective driving route development was the requirement to avoid where possible, or otherwise minimise the distance through which the route crosses the Qualifying Interest Reef habitat of the Hook Head SAC.

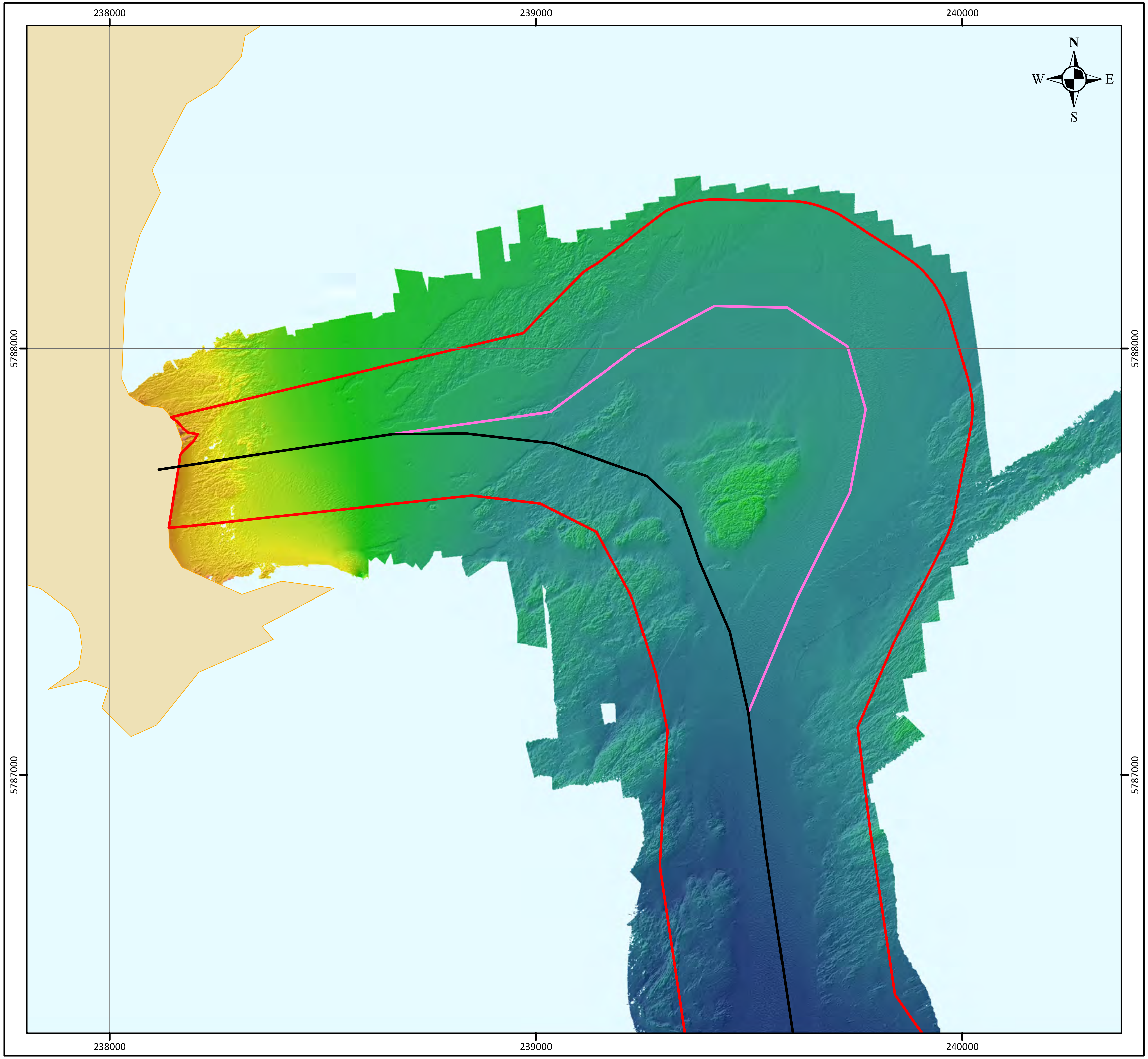
Alternative landfall locations outside of the Hook Head SAC, within the River Barrow estuary were considered but were de-selected following consultation with the Port of Waterford Company. Port of Waterford Company requested that any route within the estuary should avoid the main navigation channel and follow or be as close to as possible the outcropping rock on the eastern coastline. This constraint combined with the environmental sensitivities of the River Barrow estuary (i.e. reef habitat and important twaite shad spawning habitat), led to the recommendation that Baginbun Beach should be considered the preferred landfall for cable route survey.

NPWS were consulted throughout the route development (see Appendix D for meeting minutes) and have been clear from the start of the process that the use of external cable protection on Qualifying Interest Reef habitat has the potential to have a likely significant effect on the Hook Head SAC. However, it was also discussed that if a route can be found that avoided this requirement, trenching through the subtidal sands would be considered acceptable if the AA process demonstrated that there is no significant effects on the integrity of the SAC either alone or in combination with any other plans or projects.

INFOMAR bathymetry data and NPWS habitat maps of the Hook Head SAC were used to inform route development, and a centreline was designed that avoided the Annex I habitat Qualifying Interests.

During cable route survey, two route options (A and D) were investigated on the approach to Baginbun Beach (Figure 2-2, Drawing P1975-SURV-013). The small sand channel on Route A between outcropping rock features was approximately 35m wide at the narrowest point. This outcropping rock falls under the definition of Annex I Reef (stony reef); a Qualifying Interest of the Hook Head SAC. Mapping of the bedrock reflector shows that installation of the cable along Route A would likely require external cable protection e.g. rock berm, in order to protect the cable.

However, mapping of the bedrock reflectors on Option D shows that there is sufficient sediment depth around the loop to achieve the likely required burial depths and protection for the cables. Therefore, although Option D increases the length of the cables, it has been selected as the preferred route as it avoids the Qualifying Interest and avoids the requirement for external rock protection, except at the two HDD exit points where external rock protection maybe required (Section 2.8.3).



GREENLINK INTERCONNECTOR

SURVEY DATA

Survey Bathymetry for Route A and Option D

Drawing No: P1975-SURV-013	A

Legend

Greenlink Interconnector Proposed Routes

- Route A Rev1
- Option D Rev1
- Proposed Development

Surveyed Bathymetry

Depth Below LAT (m)

High : 20

Low : -10

Date	Thursday, April 25, 2019 08:27:56
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-013.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Greenlink

Co-financed by the European Union
Connecting Europe Facility

intertek

0 100 200 300 400

2.4 Submarine cable route description

The submarine cable corridor derived from preliminary cable route engineering, consultation with stakeholders and survey is shown in Figure 1-2 (Drawing P1975-CORR-002). Kilometre points (KPs) have been assigned to the route running from KP0 at MHWS, Freshwater West, Wales to KP159.27 at MHWS, Baginbun Beach. The proposed submarine cable corridor crosses the UK/Republic of Ireland median line at KP73.8 and enters Irish territorial waters at approximately KP123.52.

The Proposed Development is generally 500m wide. The final cable configuration will only need a small part of this width for installation (of the order of 10-20m). It is proposed to finalise the precise position of the submarine cables within the corridor after permits are granted but before installation has commenced. Therefore, for the purpose of this assessment, effects from installation anywhere within the 500m corridor has been assessed. This will allow for optimisation of the final laid submarine cables to minimise engineering and environmental challenges.

It is likely that cables will be bundled together as a pair with no separation between the cables.

2.5 Approach to design

Greenlink has been designed through an iterative process that sought to avoid or reduce potential environmental effects. Steps taken to reduce environmental effects include:

- Sensitive environmental features were identified through a desk-based assessment that used publicly available datasets e.g. INFOMAR bathymetry, NPWS habitat maps.
- During cable route survey, an additional route option was surveyed that sought to avoid crossing an area of reef habitat by following a possible sand channel.
- Geophysical survey was widened in selected places to investigate the extent of potential reef habitat and sand wave features to see if they could be avoided.

Constraints which form part of the design of Greenlink are outlined in the Greenlink Marine EIAR; an extract of the constraints specific to avoiding effects on Natura 2000 Qualifying Interests are presented in Table 2-2. In addition, Greenlink will comply with international and national statute which is designed to avoid or abate negative environmental effects; a non-exhaustive list is provided in Table 2-3.

Table 2-2 Design constraints

Design constraints	Project Phase		
	I	O	D
The preference is to use HDD for the cable landfalls to avoid disturbance of sensitive habitats (e.g. intertidal reef habitat) and disruption on beaches.	■		
Route engineering was undertaken during the marine survey to avoid sensitive habitats where possible or to reduce the distance the submarine cable corridor crosses a sensitive feature.	■		
Submarine cables will be bundled together, which reduces which reduces the seabed footprint of installation activities and the electromagnetic field generated during operation, thus minimising any potential compass deviation effects.	■	■	
Deployment of anchors/anchor chains on the seabed will be kept to a minimum in order to reduce disturbance to seabed.	■	■	■
Project vessels will not exceed 14 knots within the Proposed Development.	■	■	■
GIL will require that the appointed contractor(s) follow the Department of Arts Heritage and the Gaeltacht (DAHG) 'Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (DAHG 2014); in particular Section 4.3.4	■	■	■
A UXO survey will be undertaken less than 6 months prior to installation works commencing. If any significant UXO are identified the following decision making process will be followed: 1. Avoid by micro-routeing the marine cables. 2. If it cannot be avoided, consider whether it is safe to move. 3. If it cannot be moved, detonate on site.	■		
GIL will require that the appointed UXO contractor follows the follow the Department of Arts Heritage and the Gaeltacht (DAHG) 'Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (DAHG 2014); in particular Section 4.3.5 'Blasting' including (but not limited to): ▪ At least one qualified and experienced marine mammal observer (MMO) shall be appointed to monitor for marine mammals. ▪ Only the minimum quantity of explosives to achieve the desired result must be used. ▪ Establishing a default 1km mitigation zone for marine mammal observation, measured from the explosive source and with a circular coverage of 360 degrees. ▪ Only commence explosive detonations during daylight hours and good visibility. ▪ If necessary, plan the sequence of multiple explosive discharges so that, wherever possible, the smaller charges are detonated first to maximise the 'soft-start' effect. ▪ In waters up to 200m deep, the MMO shall conduct a pre-start up constant effort monitoring at least 30 minutes before the detonation. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO.	■		
Post-installation inspection surveys will be conducted along the length of the cables on a regular basis.		■	

Design constraints	Project Phase		
	I	O	D
Rock and mattresses will only be deployed where adequate burial cannot be achieved. The footprint of the deposits will be the minimum required to ensure cable safety and rock berm stability.			

Table 2-3 Legal requirements

Legal requirements	Project Phase		
	I	O	D
Ballast water discharges from Project vessels will be managed under the International Convention for the Control and Management of Ships' Ballast Water and Sediments standard.			
The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation.			

2.6 *Project schedule*

The programme for the commencement of installation is expected to take approximately 36 months from start to finish. The project is envisaged to commence on-site construction in late 2020 and be fully operational in 2023. Table 2-4 presents an indicative programme of marine works for Greenlink.

In general installation in European waters are undertaken in the summer season, broadly between April and October. This period is determined primarily by the high probability of adverse weather occurring outside of this period. The schedule will also be affected by factors such as, the availability of cable, the delivery of cable, other commitments of the installation contractor, and any Project Specific Mitigation proposed by the environmental impact assessment (EIA) process.

Table 2-4 Indicative programme for marine works

Activity	Duration (months)	2021				2022			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Landfall preparations - Ireland*	3								
Landfall preparations - Wales*	5								
Pre-lay survey	1								
Route preparation	1								
Cable lay & burial	3								
External cable protection installation	1								

* Sequencing of landfall preparation works may change

2.7 Pre-installation works

2.7.1 Survey requirements

Although detailed engineering surveys have been completed for the proposed submarine cable corridor (autumn 2018 – spring 2019), further surveys will be completed prior to the commencement of cable installation. This typically takes place 3-6 months ahead of installation.

The primary objective of these surveys is to confirm that no new obstructions have appeared on the seabed since the detailed engineering surveys, and to complete a unexploded ordnance (UXO) clearance survey. The survey will involve a range of standard geophysical survey techniques such as multi-beam echosounder (MBES), side scan sonar (SSS), sub-bottom profiler (SBP) and magnetometer.

2.7.2 Route preparation

Prior to the start of marine cable installation, it is essential to ensure the proposed centreline is clear of obstructions that may hinder the installation works. A pre-lay grapnel (a wire with a string of specially designed hooks) will be towed along the entire route to remove any debris.

Discrete areas of seabed will also require preparatory works known as pre-sweeping. A dredger or mass flow excavator will be used in areas of mobile sandwaves to remove a portion of the sandwave. This is to allow the cable to be buried relative to a non-mobile reference level below the lowest level of undulations; reducing the risk of the cable becoming exposed through sandwave movement. The area to be pre-swept has to be wide enough for the passage of the trenching equipment and is typically 10-20m wide. All areas requiring pre-sweeping are within the Irish Offshore component of Greenlink.

2.7.3 Route preparation at subsea cable crossing locations

Greenlink crosses one out-of-service telecommunications cable within the Proposed Development and four in service telecommunications cables in the Irish Offshore (Table 2-5). GIL is in discussions with the owner to cut the out-of-service cable.

Greenlink will cross the in-service cables on a 'bridge' comprised of either aggregate (rock) or concrete mattresses. This first layer of protective material that will be positioned during route preparation. Construction of the remainder of the crossing will occur once the cables are laid, and will consist of a graded rock berm approximately 120m in length, up to 1.2m high, covering an area of 1009m^2 per crossing.

Table 2-5 Key worst-case assumptions for crossings

Asset name	Length of external protection (m)	Seabed footprint of crossing (m^2)	KP	Sediment & EUNIS Habitat
Irish Offshore				
SOLAS	120	1009	KP121.535	Sand - A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand
ESAT 1	120	1009	KP102.513	Sand - A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand
Pan European Crossing 1	120	1009	KP95.935	Sand - A5.252 - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand
Hibernia Seg D	120	1009	KP86.7	Sand - A5.252 - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand
Assumptions				
Height of rock berm 1.2m; Rock berm crest 1m wide; Berm side slope 1:3 profile				

2.7.4 Unexploded ordnance (UXO) clearance

During route design a UXO desk top study was prepared (1st Line Defence 2018), which describes the risk of encountering UXO's along the cable route. In the Proposed Development, the risk is from large items of ordnance, mainly sea mines, in the offshore area.

The primary objective will be to avoid encountered potential UXO by micro-routeing within the permitted corridor. If re-routeing around a particular potential UXO appears not to be possible, and visual inspection confirms a UXO, then if it is safe to do so the UXO will be removed. As a last resort demolition measures will be undertaken in accordance with Best Practice.

UXO detonation in Ireland is deemed very unlikely, however for the purposes of this assessment it is assumed that one UXO denotation of up to 794kg in size will be required to present a worst case scenario. This assumption is based on the largest explosive device to have been used historically in the region. It should be noted that this size of magnetic anomaly has not been identified in the 2019 cable route survey data.

2.8 Cable installation

2.8.1 Installation vessels

The cable lay operation will be performed on a 24-hour basis. It is anticipated that the following vessel types will be required for cable installation:

- Cable lay vessel (CLV) - a specialist ship designed specifically to carry and handle long lengths of heavy power cables. CLV's are equipped with dynamic positioning (DP) systems.
- Jack-up barge (JUB) - a small platform that typically has four to eight legs. It may be used in water depths of less than 10m to support the pull-in of the cables. May be supported by a tug, which would tow it into position.
- Cable lay barge (CLB) - may be used in water depths of less than 10m instead of the CLV.
- Small work boats – support the CLV, CLB and JUB e.g. during cable pull-in operations.
- Guard vessel - used to protect areas of exposed cable prior to external protection being applied.
- Rock placement vessel – used to deposit the external protection material e.g. rock berms.

2.8.2 Cable laying

Two cable installation techniques are being considered for the Proposed Development:

- Simultaneous lay and burial – in this operation the CLV may tow the burial equipment or it is deployed by another vessel navigating close behind, creating effectively a single large spread. The cables are fed into the burial equipment directly from above and the cables are buried as the spread progresses along the route.
- Post-lay burial – in this operation the CLV lays the cables on the seabed first. A post-lay burial vessel follows to bury the cables. The post-lay burial vessel may be some physical distance, or indeed some days, behind the lay vessel, so there are two discrete operations separated physically and in time.

It may be necessary to install the cables in two sections. The end of the installed section will be temporarily left on the seabed whilst the CLV picks up the new cable. Depending on the local situation (i.e. threat levels) the end of the cable may be temporarily buried into the seabed. A ground wire will be attached to the end of the cable to enable retrieval of the end of the cable to allow cable laying to continue.

Cable joints will be made on board the CLV and will take up to a week to complete per joint location. In this time the vessel is likely to anchor to maintain position. Once the cable joint has been made on board the vessel cable laying will continue as normal.

2.8.3 Cable burial and protection

Grab samples taken during the cable route survey in Irish waters indicate a homogeneous seabed consisting primarily of sand, within the Proposed Development and Irish Offshore. Bedrock is found outcropping and sub-cropping close to the Co.Wexford coastline. The choice of burial technique or protection method will depend upon the seabed conditions in each section. The preference is burial in the seabed as this provides the best protection. Where the seabed composition is not suitable for burial, external mechanical protection will be provided through rock placement or concrete mattresses.

There are three generic types of equipment for installing cables into the seabed:

- Jetting machines – use water jets to fluidise the seabed and allow the cable to sink into the seabed.
- Cable ploughs - like ploughs used in farming, a narrow blade (the plough 'share') is pulled through the seabed to create a furrow.
- Cutting - a trench is cut using a wheel or a driven chain cutter to break and move rock and hard sediments.

A typical trench is up to 1m wide. The overall footprint of the installation machinery is approximately 15m wide. Whilst jetting is considered to have the least effect on the environment because the footprint of the tool is smaller than other installation tools such as ploughs, the use of jetting tools does result in higher suspended sediment concentrations. However, in a review of seabed disturbance from various activities it was observed that disturbance resulting from jetting was largely restricted to fines and remained low in comparison with dredging and some fishing techniques (BERR 2008).

The recommended target burial depths along the cable length were determined in a detailed Cable Burial study (Intertek EWCS 2019) using the Carbon Trust cable burial risk assessment (CBRA) methodology. This concluded the target burial depth is 1.0m for all areas of loose sediment (sands / gravels) and 0.6m for areas of glacial till.

A preliminary assessment of cable installation methods (Table 2-6) indicates that burial in sediment is likely for the entire Proposed Development and Irish Offshore, with the exception of at the third-party asset crossings and a contingency for external cable protection at the horizontal direction drill exit points.

Table 2-6 Potential installation method

Cable Protection Option	Length (km)	
	Irish Offshore	Proposed Development
Burial in sediment (jetting or ploughing)	49.24	35.63
Rock placement only	0.48	0.02+
Potential burial in rock or rock placement	0.00	0.00
Total	49.72	35.65
+ Includes contingency to use external cable protection at HDD exits. Described in Section 2.7.1.2		

2.9 Cable landfall

The landfall is where the marine cables come ashore. In Ireland, the landfall is located at Baginbun Beach, County Wexford (illustrated in Figure 1-2).

The shore crossings will be accomplished by horizontal directional drilling (HDD) which will exit seaward of the low water mark. There will be no works on Baginbun beach between MHWS and mean low water.

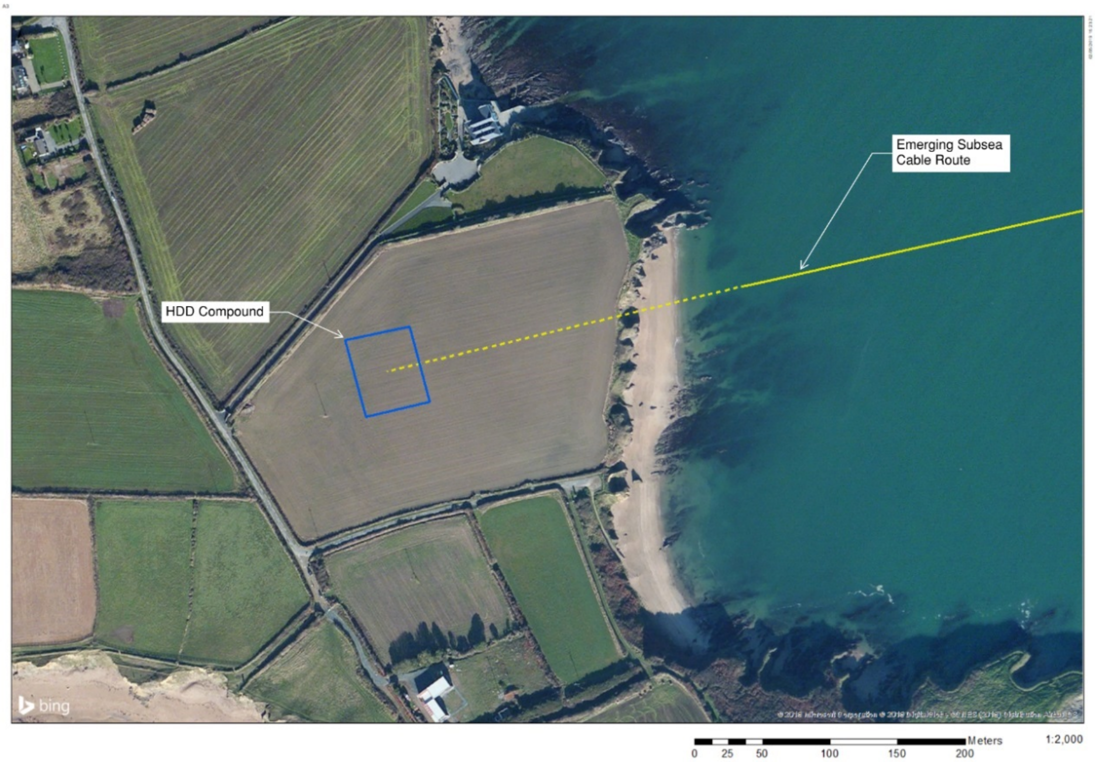
The landfall will be prepared in advance of the arrival of the CLV, so that the vessel is not delayed in its operations. This will involve the digging of transition joint pits (TJPs) above MHWS and the installation of cable ducts using HDD from the TJP to an exit point below mean low water.

2.9.1 HDD compound and transition joint pits (TJP)

The HDD compound, from which drilling will take place, will be sited above MHWS as shown in Figure 2-3.

The land cables will connect with the marine cables in a TJP, buried in the ground within the area used for the HDD compound. Up to two TJPs will be dug. Each bay will be 10-15m long, 2-3m wide and 2-3m deep below ground level; covering a maximum area of $45m^2$ per TJP.

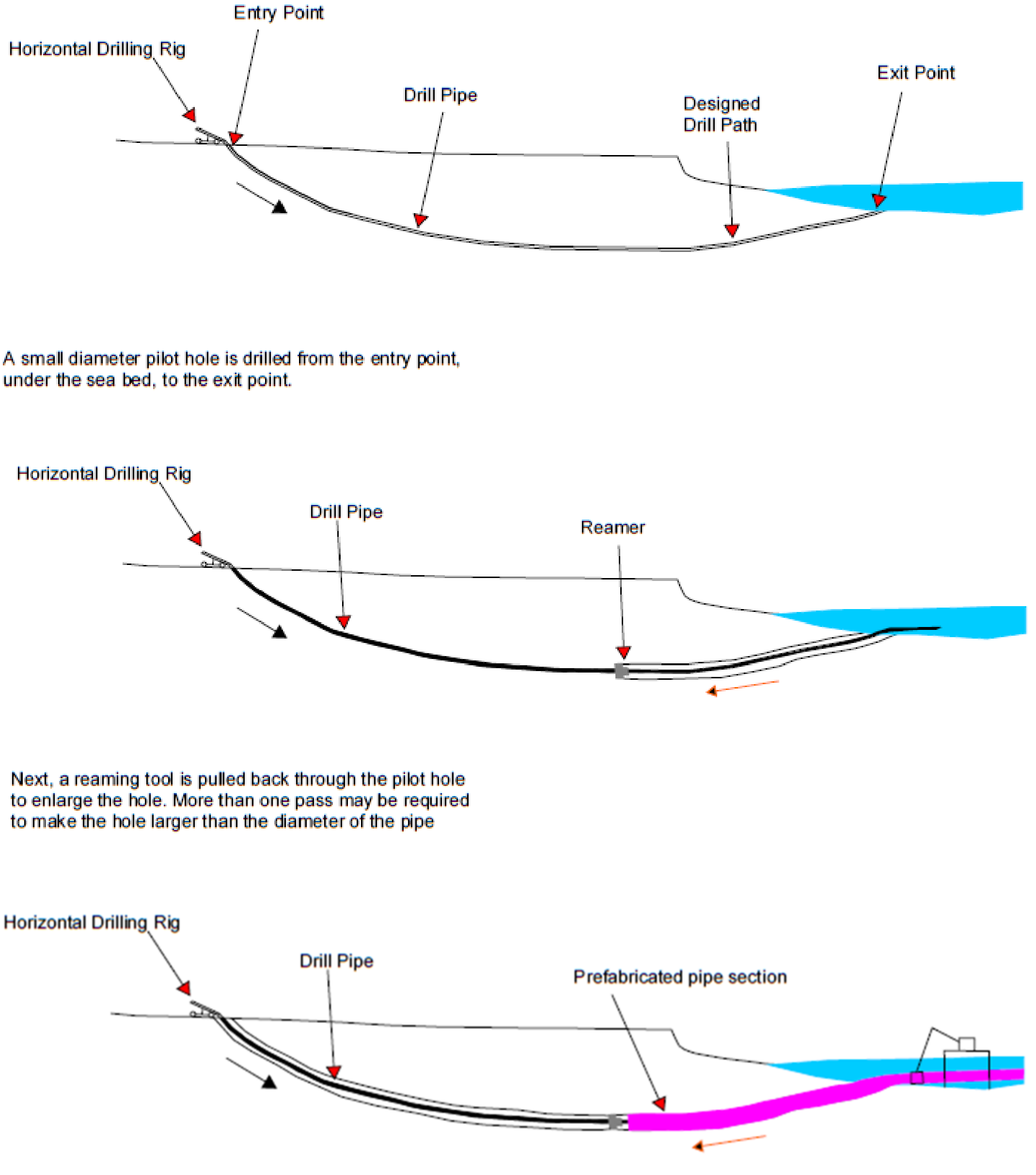
Figure 2-3 Indicative location of HDD compound – Baginbun Beach, County Wexford



2.9.2 Installation of ducts - HDD

HDD is a surface-launched process for boring a hole, under any sensitive features, to a point a suitable distance in the nearshore. A pipe is inserted into the drilled hole which is used as a duct into which the cables are installed. Figure 2-4 illustrates a typical shore to sea bore.

Figure 2-4 Typical HDD



Prefabricated pipe is attached to a swivel behind the Reamer and pulled into place under the beach

The cable ducts will pass approximately 10m below the beach.

Three ducts will be drilled; two for use and one as a spare. The fibre optic cable will be installed in a duct with one of the power cables. The ducts will fan out of the TJP to achieve exit points for the marine cables in the nearshore, with a separation distance of approximately 10m. From the exit point the cables will then merge back together, usually within 100m to form the bundle.

2.9.3 HDD exit point

The shore crossing will be made using HDD from an agricultural field behind Baginbun Beach to a point below the low water mark; avoiding any works on the beach.

The Greenlink cable route survey established that an area of Annex I Bedrock Reef habitat extends from the intertidal zone to below the low water mark. The feature extends across the width of the Proposed Development and is approximately 200m long (from beach to sea).

As the final design of the HDD has not been completed the EIA process assumed, for the purposes of worst case assessment, that the HDD could exit within this area of fringing Bedrock Rock. However, in order to protect the cables from the HDD point to a depth where burial in sediment is achievable, it is likely that cutting equipment would be required to cut a trench in the Bedrock Reef. The cables would also need external cable protection; likely in the form of a rock berm up to 10m wide. It is estimated that the footprint of external protection within this habitat would cover 2000m^2 (0.002km^2).

GIL have consulted with NPWS throughout the design of the project regarding routeing a cable through the Hook Head SAC. NPWS have been clear from the start that the use of external cable protection on Qualifying Interest Reef habitat has the potential to have a likely significant effect on the habitat. Although there is scope that external cable protection will be colonised by a similar reef habitat, potentially reducing the significance of the effect, other factors were taken into consideration when considering the environmental implications of the HDD exit point. For example:

- A rock berm just below the low water mark on the fringing reef would modify wave patterns, which in turn will effect sediment transport along the beach;
- There would be a local scour concern with respect to the feature (current and wave driven);
- A rock berm would have a significant visual effect on the landscape values of the beach. As a popular public beach, with historic connections, a negative change in the recreational value of the beach would be considered significant.

The EIA process concluded that the significance of the effects could not be adequately assessed without coastal processes modelling but there was the potential that effects could be significant and would likely effect the integrity of the Hook Head SAC. For this reason an engineering solution was investigated to avoid the negative environmental effects.

Review of the Greenlink geophysical data has been undertaken to determine where there is a sufficiently deep sediment unit to allow the HDD ducts to exit and the cables to be trenched directly into the seabed post-lay. Data suggests that burial in sediment is achievable past the 9m water depth contour. Preliminary design of the HDD has been undertaken, but the final design will be completed by the Installation Contractor. Based on the geological conditions at Baginbun Beach, a target area for the HDD exit has been prescribed through the EIA process. The Installation Contractor will be required (through Contract conditions) to engineer the HDD to exit in this area, or further seaward. Presented as the orange hatched box in Figure 2-5 (Drawing P1975-INST-002), the area starts at the 9m water depth contour. The length of HDD proposed (between 700m to 1km) is feasible and has been proven on other engineering projects.

By prescribing a minimum target area for the HDD exit, the pressure receptor-pathway between the Proposed Development and the fringing Bedrock Reef around the low water mark has been removed.

The design being assessed in this NIS is that the HDD will exit in the orange hatched box presented in Figure 2-5 (Drawing P1975-INST-002) or further seaward, avoiding the intertidal area and any intrusive activity on the fringing Bedrock Reef.

There is a risk that due to the underlying geology, the HDD could exit at an angle which would mean that a small area of external cable protection (rock berm) could be required at the end of the ducts. As a contingency (and for the purposes of worst-case assessment), the AA process has assessed the deposition of external cable protection in the form of two rock berms, both 5.2m wide by 20m long with a height of 0.7m within the orange hatched box shown on Figure 2-5 (Drawing P1975-INST-002). It is estimated that the footprint of external protection within this area would cover of $208m^2$ ($0.000208km^2$).

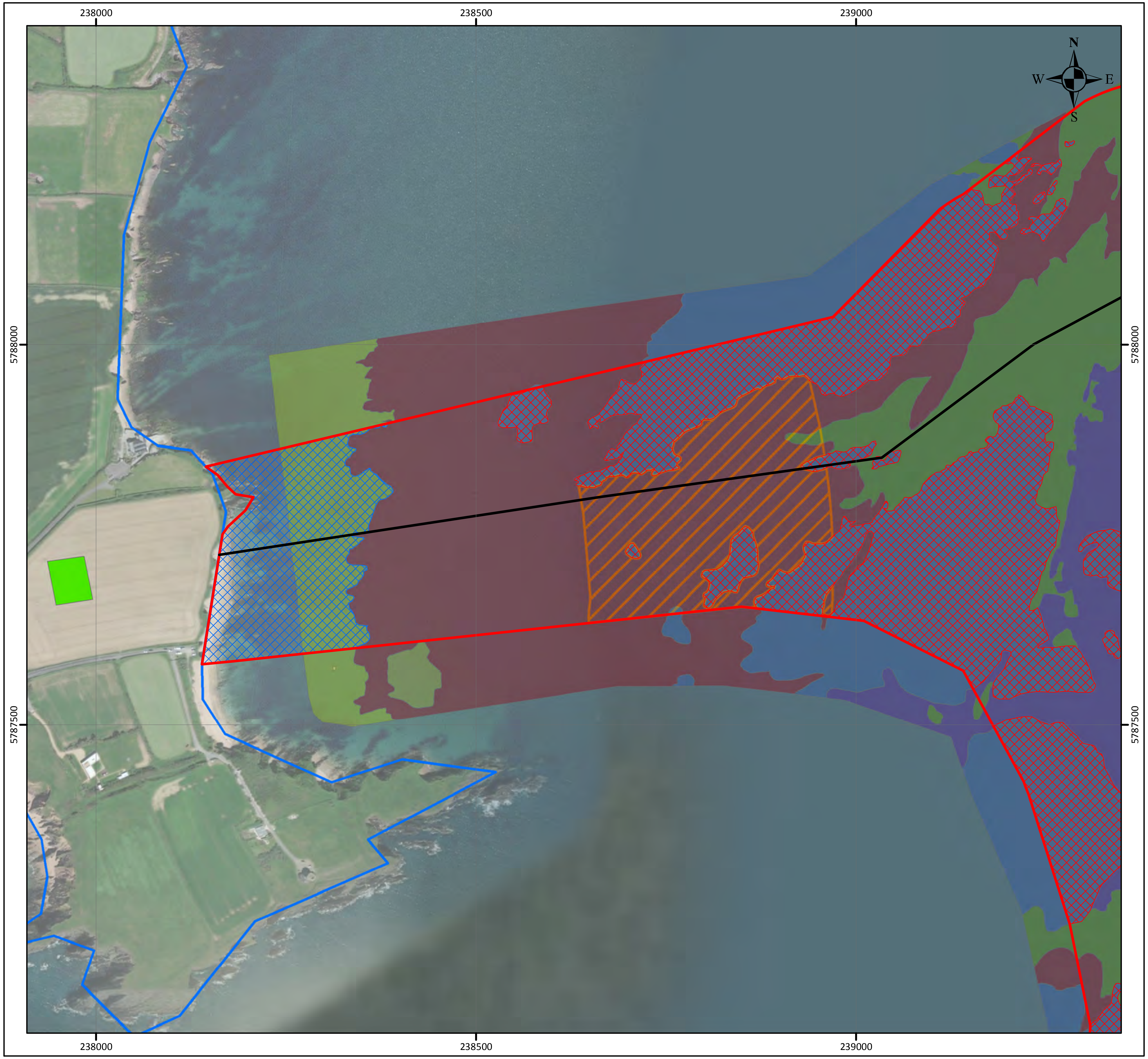
At the HDD exit points rock sizes will be in the range of 2cm to 22cm.

The installation sequence for each of the submarine cables and the fibre optic cable will be similar, and will be defined by the Installation Contractor. An indicative methodology is provided below:

- The end of the duct accepting the cable will be dug out using an excavator positioned on a jack-up barge or anchored barge.
- Material excavated will be left adjacent to the pit and refilled after the cable pull-in. The submarine cable would be floated to the exit point of the ducts. Small work boats and divers would support this activity.
- The submarine cable would then be connected to the messenger wire pre-installed in the ducts and winched from a position close to the TJP through the ducts; whereupon it can be jointed to the onshore cables.

- The cable is then installed away from the beach either using a plough or trencher (as per the offshore installation section above).

No works would be required on the beach.



GREENLINK INTERCONNECTOR

INSTALLATION

Indicative HDD Exit Point - ROI Landfall

Drawing No: P1975-INST-002	A

Legend

- Indicative Greenlink Route Centreline
- Proposed Development
- Mean High Water Mark
- HDD Compound
- Indicative HDD Exit Point
- Trenching Exclusion Zone
- Annex I Habitat Exclusion Zone

EUNIS Habitat Classification

- A3.11
- A3.2
- A5.23
- A5.24
- A5.43
- A5.44

NOTE: Not to be used for Navigation

Date	Wednesday, May 8, 2019 11:00:32
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSOD; MMT; ESRI; Greenlink
File Reference	J:\P1975\Mxd\15_INST\ P1975-INST-002.mxd
Created By	Chris Goode
Reviewed By	Chris Carroll
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 50 100 150 200 m

2.10 Campile Estuary

The onshore cable route between Baginbun Beach and Great Island crosses the Campile Estuary. It is proposed to use HDD under the Campile Estuary to make the crossing. The depth of the ducts will be greater than 10m below the river bed. Compounds either side of estuary will be setback above MHWS, within areas of improved agricultural grassland primarily used as pasture.

Figure 2-6 (overleaf) shows the location of the HDD compounds in relation to the Campile Estuary. The ‘Campile Estuary’ component of Greenlink encompasses the area of foreshore between MHWS on either side of the river.

2.11 Cable operation

2.11.1 Emissions

During operation of the cables emissions to the environment will consist of magnetic (B) and induced electric (iE) fields and heat. The influence of Greenlink on the background geomagnetic field along the cable route has been calculated to be low with B and iE fields dissipating to natural background levels within 2m of the bundled cables and 12m of the HDD exit points where the cables are separate and not bundled.

Temperature increases in the upper sediments of the seabed over buried cables are not expected to emanate further than 1m from the cable and exceed 2°C.

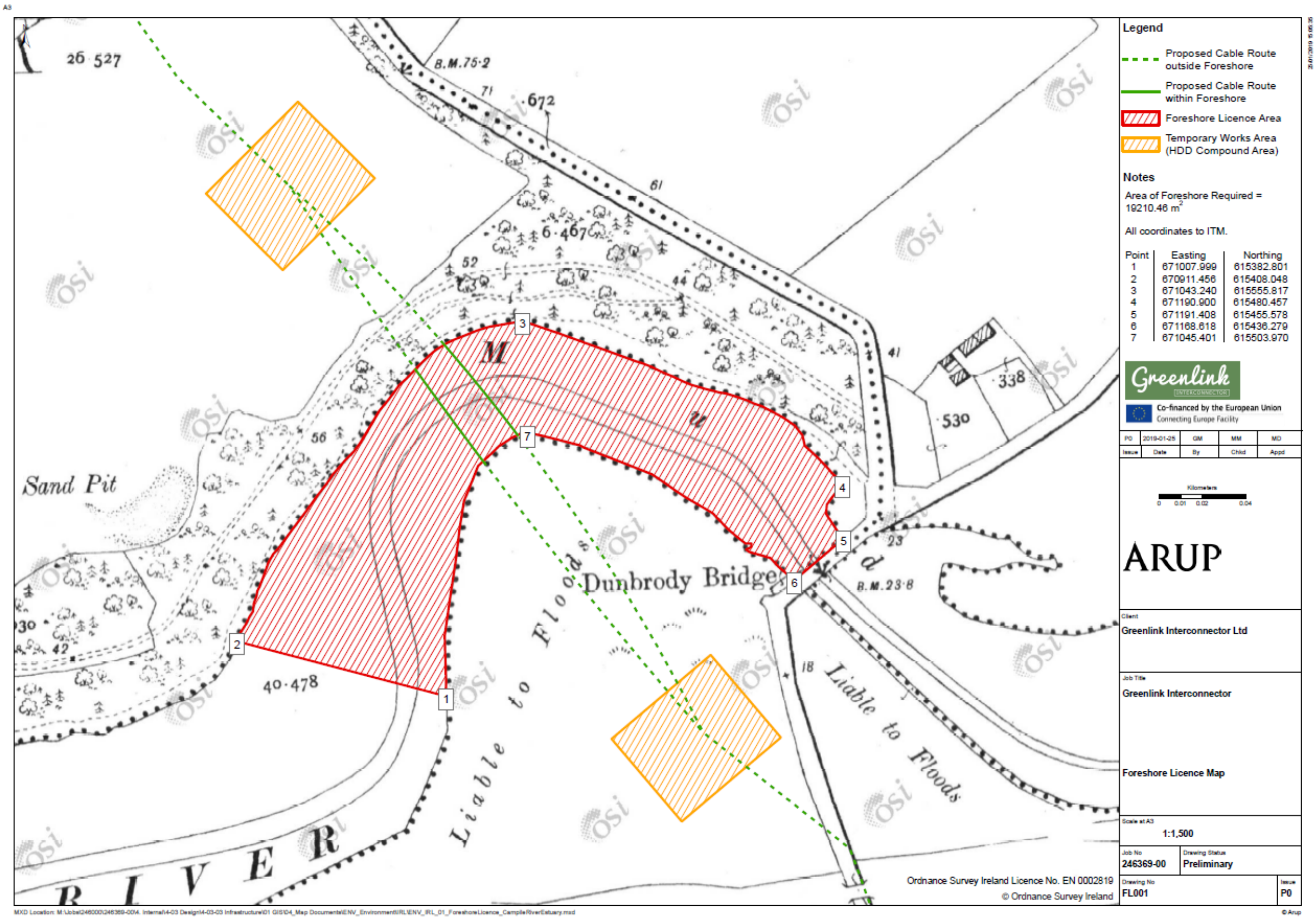
2.11.2 Maintenance and repair

It is likely that routine inspection surveys using standard geophysical survey equipment and/or remotely operated vehicles to monitor buried depth and integrity of rock berms will be undertaken, particularly in the initial years of operation, and should the local environmental conditions change or be suspected as having changed.

Once installed, marine cables are not expected to require routine maintenance. If a cable fault is detected, usually as a consequence of damage cause by external interaction e.g. trawlers and commercial ship anchors, the relevant section of the cable will be located and retrieved to surface for inspection and replacement. It may be necessary to de-bury the cable prior to cable recovery. A repair will typically be carried out by a single vessel.

A shallow water repair, in less than 10m of water, will typically be made using an anchored barge. In deeper water a dynamically positioned cable vessel will be used. As the fault location may be uncertain up to 1km has been allowed for as a replacement length. The extra length of a repaired short cable section means it cannot be returned to its exact previous alignment on the seabed. The excess cable will be laid on the seabed in a loop off to one side of the original route. The additional joints and the extra cable length will be buried, typically using jetting machines deployed from either the repair vessel itself or a separate specialised vessel.

Figure 2-6 Campile Estuary crossing



2.12 Decommissioning

GIL recognise the importance of considering the decommissioning process at an early stage and should decommissioning be undertaken the operation will be conducted according to the standard industry protocol at the agreed time.

At the end of the cable's life the options for decommissioning will be evaluated.

The objectives during the decommissioning process will be to minimise both the short and long term effects on the environment whilst making the sea safe for others to navigate. Based on current regulations and available technology, the following level of decommissioning is proposed and has been assessed:

- Cables - to be either removed or to be left safely in-situ, buried to below the natural seabed level
- Mattresses - to be left in-situ
- External cable protection - to be left in-situ

The NIS assesses the worst-case environmental effects which could either be full removal or leaving in-situ depending on the receptor.

3. Description of Receiving Environment

A full description of the receiving environment is provided in the Greenlink Marine EIAR. This section has been focused to provide a baseline for receptors associated with the Natura 2000 sites screened in Section 4.

GIL has commissioned environmental and intertidal surveys to inform the baseline description and assessment. These have been supplemented where necessary by a review of published information and consultation with relevant bodies. The specialist studies undertaken to inform the baseline include:

- Greenlink Interconnector Geophysical Survey Report (MMT 2019a) – Greenlink Marine EIAR Technical Appendix G;
- Greenlink Interconnector Environmental Survey Report (MMT 2019b) – Greenlink Marine EIAR Technical Appendix H;
- Greenlink Interconnector Cable Landfall Locations (Wales and Ireland) – Intertidal Walkover Survey Report 2018 (MarineSpace 2018) – Greenlink Marine EIAR Technical Appendix I; and
- Ecological Assessment of estuarine habitats at Campile estuary and terrestrial ecology in proximity to Baginbun Beach for a proposed electricity interconnector between Ireland and Wales (Dixon.Brosnan 2019).

3.1 Habitats

3.1.1 Campile Estuary

The Campile River at Dunbrody Bridge is tidal, with regular fluctuations in salinity and turbidity, and in the rate and direction of water flow. This section of the Campile River is part of the River Barrow and River Nore SAC. The shoreline habitat is classified as upper salt marsh habitat that has developed along the Campile River Channel. This upper section of the river is subject to less frequent and less prolonged inundation by the sea and, as a result, is not as saline in character as lower sections of the river.

The river channel has been considerably modified over time with the development of embankments along the southern bank of the river to the west of Dunbrody Bridge. The river channel embankments were created on both sides of the river banks to allow for the reclamation of intertidal habitats and to create farmland.

The embankment along the southern bank of the river to the west of Dunbrody Bridge separates the Campile River from an area of improved, heavily grazed agricultural grassland. The embankment itself, while showing some signs of grazing, is dominated by a mix of species including Sea Couch (*Elytrigia atherica*), False Oat-grass (*Arrhenatherum elatius*), Nettle (*Urtica dioica*), Bindweed (*Calystegia* spp.) and patches of Bramble (*Rubus* spp.).

The section of the Campile River to the west of the Dunbrody Bridge is dominated by mudflat habitat which is exposed during periods of low tide. However, found scattered within these areas of consolidated mud and along the river bank are areas of upper salt marsh habitat. Floral composition varies. Common Cord-grass (Spartina anglica) has become abundant in places which can cause habitat loss and degradation. Other species noted include Sea Couch, Sea Club-rush (*Bolboschoenus maritimus*), Creeping Bent (*Agrostis stolonifera*), Sea Aster (*Aster tripolium*), Orache (*Atriplex* spp.) and Sea Plantain (*Plantago maritima*). There is some evidence of grazing by cattle within this habitat.

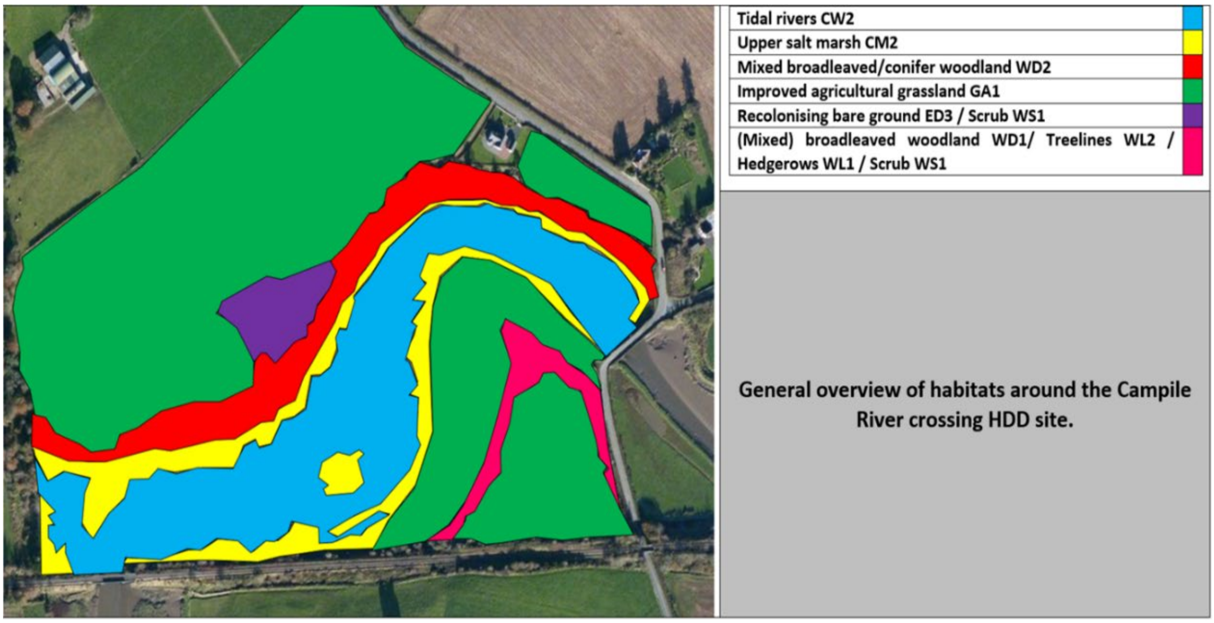
Situated to the north of this section of the Campile River, is a band of mixed broadleaved/conifer woodland. Species noted include Ash (*Fraxinus excelsior*), Oak (*Quercus spp.*), Birch (*Betula spp.*), Scots Pine (*Pinus sylvestris*), Sycamore (*Acer pseudoplatanus*) and Hawthorn (*Crataegus monogyna*). The high-risk invasive species Rhododendron (*Rhododendron ponticum*) was recorded growing within the understory of the woodland habitat at various locations.

Figure 3-1 presents the habitats identified at the Campile Estuary.

Annex I habitats currently listed as Qualifying Interests for the River Barrow and River Nore SAC include H1310 Salicornia and other annuals colonizing mud and sand; H1330 Atlantic salt meadow (*Glauco-Puccinellietalia maritimae*); and H1410 Mediterranean salt meadows (*Juncetalia maritimi*).

The upper saltmarsh (CM2) identified in Figure 3-1 is part of the Dunbrody Abbey saltmarsh, one of four Saltmarsh inventory sites found in the River Barrow estuary. The Dunbrody Saltmarsh has been mapped as covering 0.425km^2 (41.465 hectares). Of this area Spartina swards cover approximately 0.01km^2 (1.208 hectares) and other saltmarsh (CM2) covers approximately 0.039km^2 (3.928 hectares) (NPWS 2011a).

Figure 3-1 General overview of habitats west of Dunbrody Bridge



3.1.2 Subtidal habitats

The Greenlink cable route survey (MMT 2019a,b) shows that sediments within the Proposed Development consists mainly of sand, with areas of mud observed in the shallower sites. A total of 12 habitats were identified within the Proposed Development, most of which were classified as sandy habitats.

The route crosses the Hook Head SAC for a distance of approximately 8km between KP 151.258 and the landfall at Baginbun Beach, KP 159.267. The following Annex I habitats were observed within the Proposed Development.

- 1160 - Large shallow inlets and bays.
- 1170 – Reefs.

The Proposed Development follows a sediment channel through the Bedrock reef habitat; although Bedrock Reef extends across the full width of the Proposed Development in the approach to the intertidal area. The sediment channel and Bedrock Reef has been classified as within the Annex I habitat 'large shallow inlets and bays'.

No species of conservation importance were identified in grab samples from the cable route survey. No *Sabellaria spinulosa* was identified in any of the subtidal grab samples.

3.1.2.1 Stony reef (bedrock reef) (1170):

The EC Habitats Directive habitat 1170 Reefs is described as "*Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the sea floor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animals species including concretions, encrustations and corallogenic concretions.*" (European Commission 2013)

The reef habitats found in Hook Head SAC are bedrock and stony reefs of three community types: exposed to moderately exposed intertidal reef community complex, echinoderm and sponge dominated community complex, and laminaria dominated community (NPWS 2014d). None of the invertebrate species listed in the Natura 2000 standard data form for Hook Head were identified in the grab samples (MMT 2019b). Areas of Laminaria sp. was identified on outcropping bedrock within the Irish EEZ but not within the Proposed Development.

Bedrock outcrops were identified in the geophysical data within the Proposed Development; as shown on Figure 3-3 and 3-4 (P1975-HAB-004 Sheet 11 and Sheet 12) (MMT 2019b). These outcrops had been identified during route development and the indicative cable centreline follows a sediment channel between the Bedrock reef.

Photo transects were performed across the corridor at three locations (DDV_T01 at KP158.318, DDV_T02 at KP156.911 and DDV_T03 at KP 156.136) to try to visualise the bedrock reef. However, due to poor visibility from suspended sediments, no habitats or associated fauna was recorded from transects DDV_T01 and DDV_T03. Transect DDV_T02 showed kelp on bedrock (Figure 3-2). All outcropping bedrock shallower than 20m, was classified to EUNIS habitat A3.11 - kelp with cushion fauna and/or foliose red seaweeds.

Figure 3-2 Photograph from DDV_T02_001 showing Annex I (1170) – Bedrock reefs with the habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds

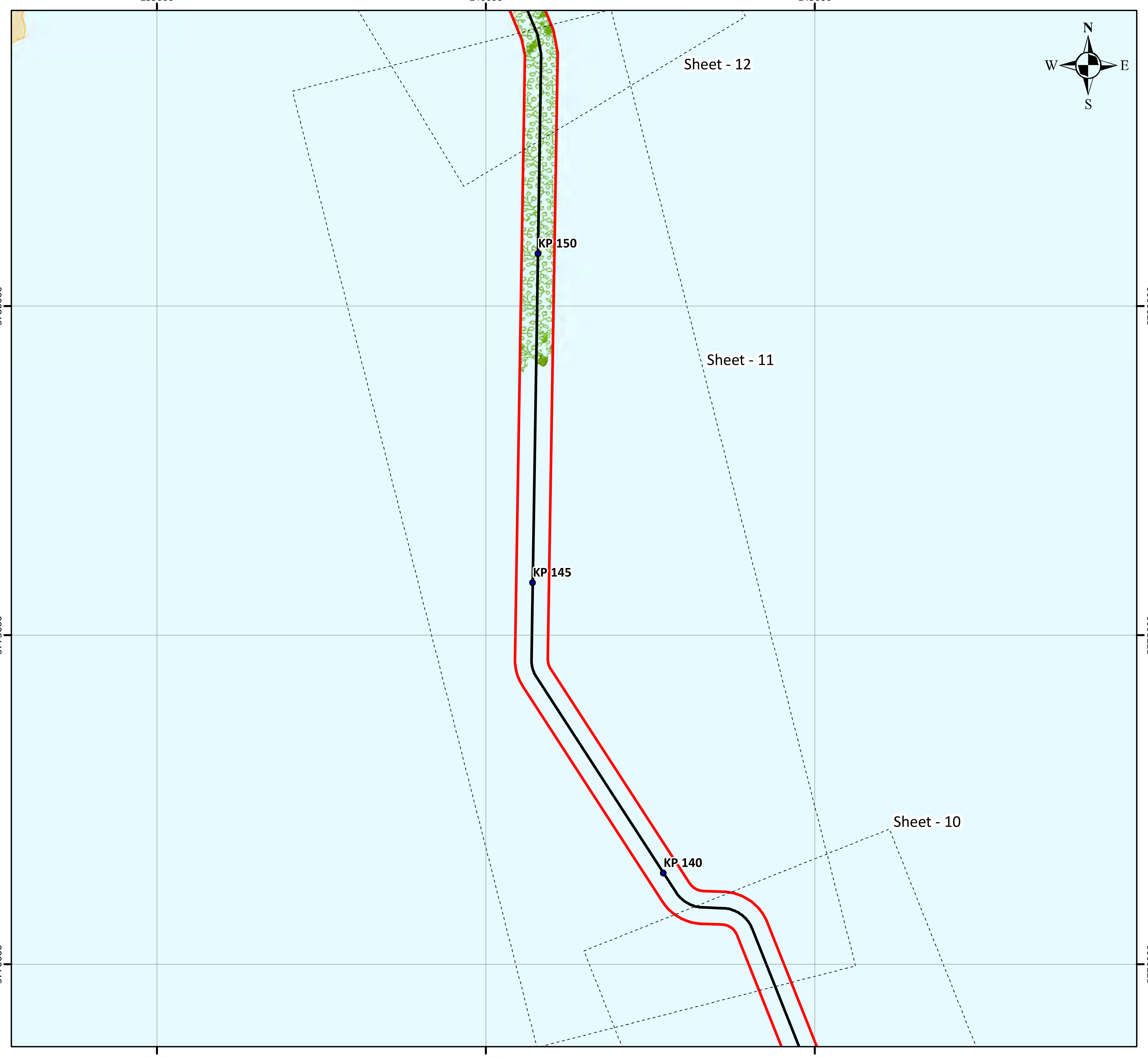
The extent of Annex I Reef habitat within the Proposed Development has been calculated as 5.33km^2; of which 4.16km^2 is within the Hook Head SAC. However, it is evident from INFOMAR bathymetry data and NPWS habitat maps for Hook Head SAC that exposed bedrock covers a greater extent, in the wider region. The extent of Reef protected by the Hook Head SAC, as stated on the Natura 2000 designation is 105.34km^2. When compared, the NPWS habitat maps and Greenlink cable route survey data generally showed a good level of alignment; although as the Greenlink cable route survey is of a higher resolution, local small scale differences were identified.

3.1.2.2 Large shallow inlets and bays (1160):

Large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. Several of these habitat types (‘1140 Mudflats and sandflats not covered by sea water at low tide’, ‘1110 Sandbanks which are slightly covered by sea water all the time’ and ‘1170 Reefs’) are listed as Annex I habitats in their own right.

Large shallow inlets and bays are large indentations of the coast, generally more sheltered from wave action than the open coast. They are relatively shallow (with water less than 30m over most of the area), and in contrast to habitat ‘1130 Estuaries’, generally have much lower freshwater influence (JNCC 2019h).

Figures 4-3 and 4-4 (P1975-HAB-004 Sheet 11 and Sheet 12) show areas along the Proposed Development which are classified as large shallow inlets and bays.



GREENLINK INTERCONNECTOR

ANNEX I HABITATS
Survey Data - Sheet 11

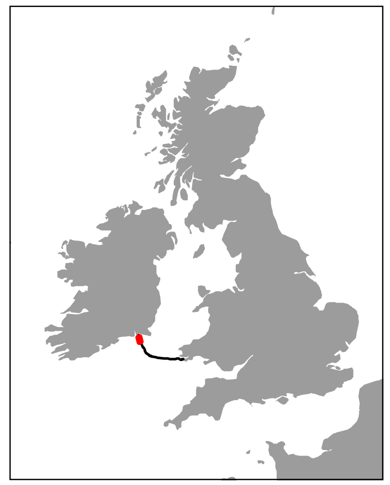
Drawing No: P1975-HAB-004	A

Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development

Annex I Habitat Classification

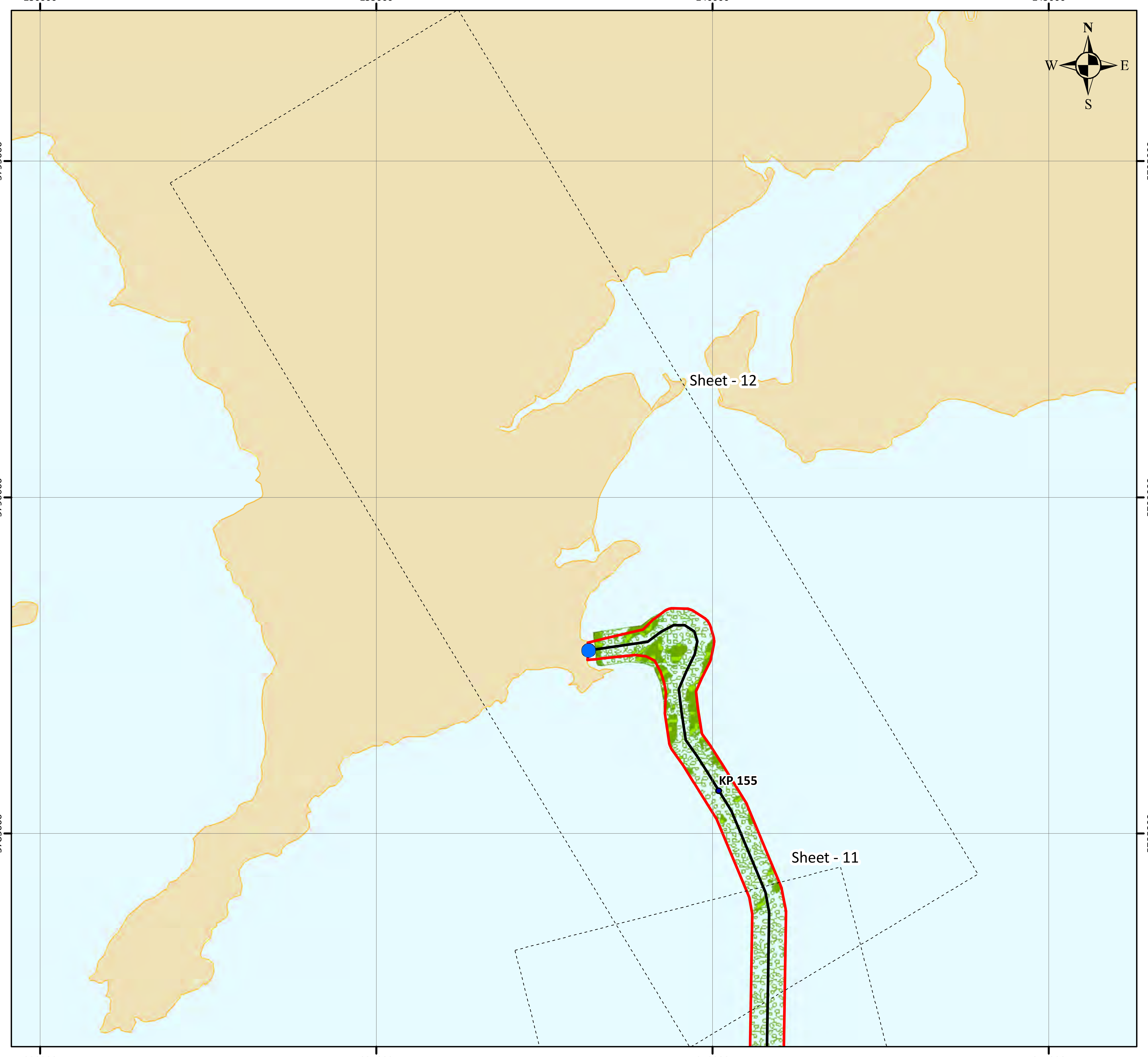
- Large Shallow Inlets/Bay
- Bedrock Reef



Date	Monday, April 8, 2019 12:43:10
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

ANNEX I HABITATS
Survey Data - Sheet 12

Drawing No: P1975-HAB-004	A

Legend

Landfall

Baginbun Beach

Greenlink Route Centreline (Indicative)

Proposed Development

Annex I Habitat Classification

Large Shallow Inlets/Bay

Bedrock Reef

NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 12:43:10
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km

3.2 Fish

Four Annex II listed fish species are likely to be found within or near the Proposed Development at certain times of the year:

- Sea lamprey (*Petromyzon marinus*) – late July-April;
- River lamprey (*Lampetra fluviatilis*) – July to April;
- Twaite shad (*Alosa fallax*) – April onwards
- Atlantic salmon (*Salmo salar*) – May to June and autumn months.

These species are diadromous, meaning they migrate between marine and freshwater as part of their lifecycle; the Celtic and Irish Sea is an important migration route for these species.

Atlantic salmon, twaite shad and three lamprey species (sea lamprey, brook lamprey and river lamprey) are Qualifying Interests for the River Barrow and River Nore SAC. Brook lamprey (*Lampetra planeri*) does not migrate to the sea and therefore will not be observed in the Proposed Development.

Twaite shad and Atlantic salmon has known spawning grounds at the upper tidal reaches in the River Barrow and River Nore SAC. Twaite shad spawns between April and May and Atlantic salmon spawns between November and January. River lamprey and sea lamprey may also be observed spawning in the river. River lamprey usually spawn in March and April and sea lamprey usually spawn in May or June. River and sea lamprey migrate into the estuary from July through to September (Maitland 2003).

Telemetry investigations by the Inland Fisheries Ireland indicate that Twaite shad do not move in a single event to spawning areas but make a series of up- and downriver migrations, dropping far down into the Waterford Harbour area, at least, prior to settling for a short period in the spawning areas. The telemetry work and sampling in the near-shore marine areas indicate that the adult shads migrate in- and out of the estuarine areas and open sea, presumed to be feeding movements. The telemetry study has also shown movements from one estuary to another, one fish moving from the Munster Blackwater to Waterford Harbour over the course of two to three days immediately after spawning. Comments received from Inland Fisheries Ireland on the Foreshore License application for the Greenlink marine survey indicates that they consider that shad movements are occurring all of the time between the open sea area and the estuarine area around Hook Head.

3.3 Birds

3.3.1 Campile Estuary

Table 3-1 presents bird count data from the 2018/2019 winter bird survey at the Campile Estuary. Three vantage points, north of railway, south of railway and west of Dunbrody Bridge were selected to inform the baseline.

Table 3-1 Bird count data - Campile Estuary

Species	1% National	1% International	South of Railway	North of Railway	West of Dunbrody Bridge
Black-headed gull		20000	83 (LT)	16 (LT)	2 (LT)
Common gull		16400	2 (LT)		
Grey Heron	25	2700	1 (LT & HT)	1 (LT)	1 (LT)
Little Egret	20	1300	2 (LT)	2 (LT)	1 (LT)
Cormorant	120	1200		1 (LT)	
Curlew	350	8400	17 (LT)	22 (HT)	2 (LT)
Black-tailed Godwit	190	610	32 (LT)	3 (LT)	2 (LT)
Greenshank	20	2300	3 (LT)	3 (LT)	3 (HT)
Redshank	300	3900	26 (HT)	14 (HT)	3 (LT & HT)
Snipe		20000	9 (LT*)	4 (HT)	
Green Sandpiper		15500			1 (LT)
Turnstone	95	1400	3 (LT)		
Dunlin	570	13300	5 (LT*)		
Wigeon	630	15000	15 (LT)	14 (HT)	
Teal	340	5000	15 (LT)	18 (HT)	23 (HT)
Kingfisher				1 (HT)	1 (LT)
Little Grebe	20	4000	1 (LT)		
Red-throated Diver	20	3000	1 (LT)		
Notes	LT denotes Low tide; HT denotes high tide * Tide receding during survey period, exposing mudflat habitat in which waterbirds forage.				

Of the species noted, the following are listed on Annex I of the EC Birds Directive:

- Little Egret (Egretta garzetta)
- Kingfisher (Alcedo atthis)
- Red-throated Diver (Gavia stellate)
- Dunlin (Calidris alpine)

None of the waterbirds recorded by vantage point counts were recorded in high numbers and numbers were low in-comparison to the figures which would be considered nationally significant (i.e. 1% or more of the all-Ireland population of an Annex I species or 1% or more of the bio-geographical population of a migratory species).

3.3.2 Proposed Development

A winter bird count was undertaken at Baginbun Beach for the season 2018/2019. Species observed included Herring gull, great black-backed gull, Lesser black-backed gull, grey heron, cormorant, shag, common guillemot, razorbill, oystercatcher, great northern diver and red-throated diver. Of the species noted Great Northern Diver (*Gavia immer*), Merlin (*Falco columbarius*) and Red-throated Diver (*Gavia stellate*) are listed on Annex I of the EC Birds Directive.

None of the seabirds recorded were seen in high numbers. Numbers were low in comparison to what would be considered nationally or internationally important; although 10 great northern diver were counted which is equivalent to 0.5% of the all-Ireland population.

The following SPAs are located within 10km of the Proposed Development and it is possible that birds from the sites could be present in the Proposed Development:

- **Saltee Islands SPA**– The Proposed Development lies 10km from the site. The Saltee Islands are internationally important for holding an assemblage of over 20,000 breeding seabirds. The nationally important gannet colony on Great Saltee has been well documented since its establishment in the 1920s and 2,446 pairs were present in 2004. The following species have populations of national importance (all counts in the 1999/2000 breeding seasons): fulmar (525 pairs), cormorant (273 pairs), shag (268 pairs), lesser black-backed gull (175 pairs), great black-backed gull (c. 90 pairs), herring gull (73 pairs), kittiwake (2,125 pairs), guillemot (21,436 individuals), razorbill (5,200 individuals) and puffin (1,822 individuals). An estimated 250 pairs of Manx shearwater occur on these islands. There are also breeding peregrine falcons (1-2 pairs) and chough (1 pair) (NPWS 2012).
- **Keeragh Islands SPA** - The Proposed Development lies 4.5km from the site. The islands have a nationally important breeding colony of cormorant (206 pairs recorded in 1989), which is considered to be one of the largest in the country. The colony has been well-monitored since it was first recorded in 1968 and there has been a long-term ringing programme. It retains potential for attracting breeding terns, species that are listed on Annex I of the EU Birds Directive, though none have been recorded since the 1970s.

  In winter the islands are a refuge and night roost for flocks of Brent goose and for ducks, notably mallard and wigeon with smaller numbers of teal and shoveler (NPWS 2014a).

- **Bannow Bay SPA**– The Proposed Development lies 1.6km from the site. Most of the estuary has been designated a SPA because of its significant bird interest, particularly during the winter. Parts of this area have also been designated a wildfowl sanctuary. Large numbers of wintering wildfowl and waders feed on the mudflats and sandflats, and use the fringing vegetation of reedbed and saltmarsh for roosting and feeding. Populations present include internationally important numbers of light-bellied brent goose (819), and nationally important numbers of shelduck (475), pintail (85), oystercatcher, golden plover (3,144), lapwing (2,000), knot (508), dunlin (3,850), black-tailed godwit (697), bar-tailed godwit (334) and redshank (377) (all figures mean peaks 1994/95 to 1997/98) (NPWS 2014b).
- **Ballyteige Burrow SPA** - The Proposed Development lies 8.1km from the site. It is a major site for wintering waterfowl, with an internationally important population of Brent goose and a further six species with populations of national importance. Of particular note is that two of the species, golden plover and bar-tailed godwit, are listed on Annex I of the EU Birds Directive. Little tern is also listed on Annex I of this Directive. Most of the site is also designated as a Nature Reserve (NPWS 2014c).

3.4 *Pinnipeds*

Grey seal and common/harbour seal are listed under Annex II of the EC Habitats Directive. Sightings of harbour seal within the vicinity of the Proposed Development are infrequent. Grey seal sightings are common with between 5-10 individuals per $5km^2$ within the Proposed Development increasing to 10-50 animals per $5km^2$ within the Saltee Islands SAC (Russell et al 2017).

Grey seal utilise the area of the Saltee Island SAC as one of the very few breeding grounds in eastern Ireland. Grey seal occupies both aquatic and terrestrial habitats in the SAC, including intertidal shorelines that become exposed during the tidal cycle and outlying rocky skerries when these are not inundated by wave action. Grey seal are present at the site throughout the year during all aspects of its annual life cycle which includes breeding, moulting and non-breeding foraging and resting phases (NPWS 2011b).

Grey seals at and around the site are vulnerable to disturbance during periods when time is spent ashore by individuals or groups of animals. This occurs immediately prior to and during the annual breeding season, which takes place predominantly during the months of August-December. Pups are born on land, usually on remote beaches and uninhabited islands or in sheltered caves (NPWS 2011b). The breeding population was estimated at 571-744 individuals in 2005. A one-off moult count in

2007 gave a figure of 246 individuals. Pupping time occurs primarily from August through to December. After three weeks the pups moult with adults congregating in large numbers on beaches between December and February to moult.

3.5 Cetaceans

All cetaceans are European Protected Species (EPS) protected under Annex IV of the EC Habitats Directive. It is an offence to deliberately kill, injure or disturb animals classed as EPS.

There are 24 species of cetacean reported in Irish waters with ten species known to be present all year round (NPWS 2015). The species of cetaceans that are frequently spotted in the waters surrounding the Proposed Development include: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), short beaked common dolphin (*Delphinus delphis*), minke whale (*Balaenoptera acutorostrata*), Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), pilot whale (*Globicephala melas*), humpback whale (*Megaptera novaeangliae*) and fin whale (*Balaenoptera borealis*) (Marine Institute 2015, IWDG 2019). Generally, the greatest numbers of cetacean species are present in coastal waters within the summer months[1].

Harbour porpoise and short beaked common dolphin are the most abundant and commonly sighted species in the area, with most sightings taking place between spring and autumn.

Harbour porpoise and bottlenose dolphin are listed under Annex II of the EC Habitats Directive. The closest Natura 2000 sites to the Proposed Development designated to conserve harbour porpoise and bottlenose dolphin lie in UK waters. Table 3-2 provides an appraisal of the frequency of sightings of these species in the region.

Table 3-2 Frequency of sightings of harbour porpoise and bottlenose dolphin

Species	Frequency of sightings*	IWDG sightings (Feb 2018 - Feb 2019)	Estimation of density (animals/km^2)**	Applicable MU***	Abundance of animals in MU***
Harbour porpoise (*Phocoena phocoena*)	Common from June through the autumn/winter. Peak period in August. Commonly recorded of the Hook Head Peninsula.	April, May, July & November. Individuals and up to 6 animals.	0.118-0.239	Celtic and Irish Seas	47,229
Bottlenose dolphin (*Tursiops truncatus*)	Common year round but most frequent in summer.	1 animal sighted July	0.008 - 0.06	Offshore Channel and SW England	4,856

Sources: * Marine Institute (2015) and Reid et al. (2003), ** Hammond et al (2017) ICES Management Units D and E (Celtic/Irish seas) and *** DECC (2016).

[1] Summer is classed as April to September and winter as October to March.

Harbour porpoise

Harbour porpoise is the most common cetacean in Irish and UK waters, it is wide-ranging and abundant, both coastally and offshore, with the most signing occurring in the coastal area, close to islands and headlands with strong tidal currents (DECC 2016). Harbour porpoise generally prefer coarser sediments which is the habitat of sandeel, a known prey species. Many sightings of harbour porpoise have been recorded by the obSERVE Project around the Hook Head Peninsula (Figure 3-5). This figure shows that harbour porpoise near to Hook head are observed all year round, with the greatest number of sightings recorded during the summer months.

Harbour porpoise are likely to be present throughout the Proposed Development throughout the year, but densities will be highest during the summer and autumn months.

Figure 3-6 shows the concentration of harbour porpoise sightings between 1990-2009.

Bottlenose dolphin

Bottlenose dolphin are a Qualifying Interest of the Cardigan Bay/ Bae Ceredigion SAC and a Qualifying Interest of the Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau SAC located over 96.3km and 150.5km, respectively from the Proposed Development. As highly mobile species it is possible that animals from these sites may occur within the Proposed Development. However, densities of bottlenose dolphin within the Proposed Development, St Geroges' Channel and Celtic Sea are expected to be low. This is supported by the lower frequency of sightings from the IWDG.

Figure 3-5 Harbour porpoise sightings

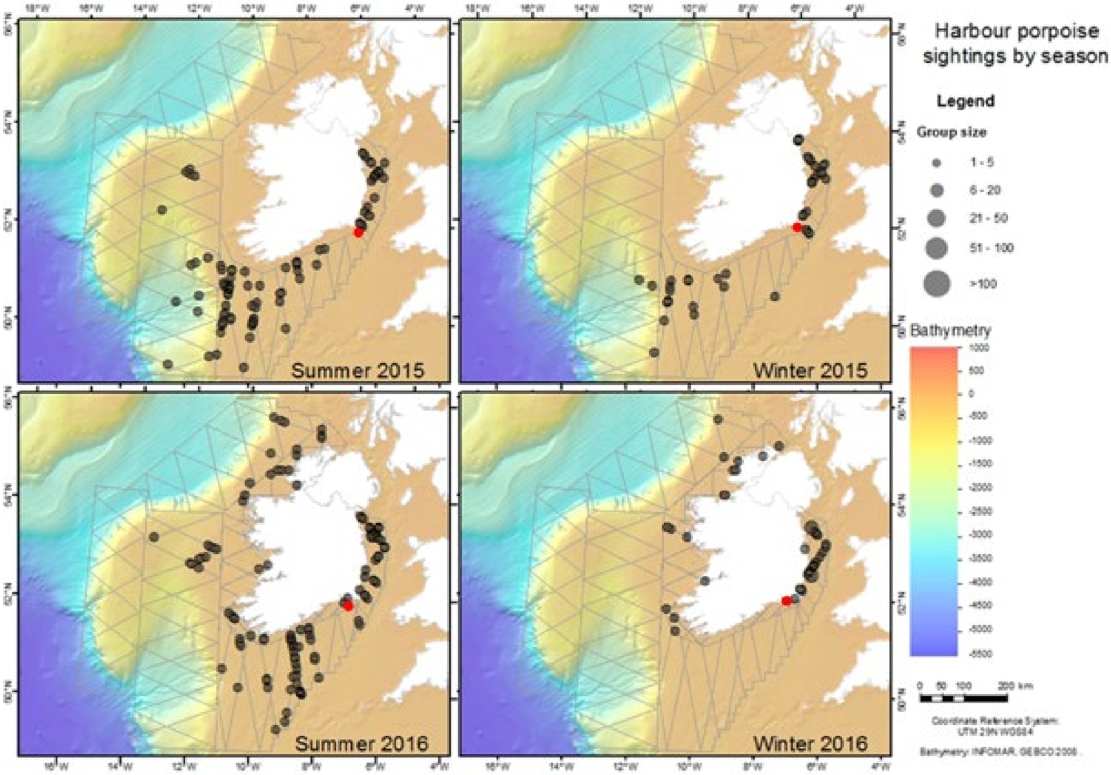
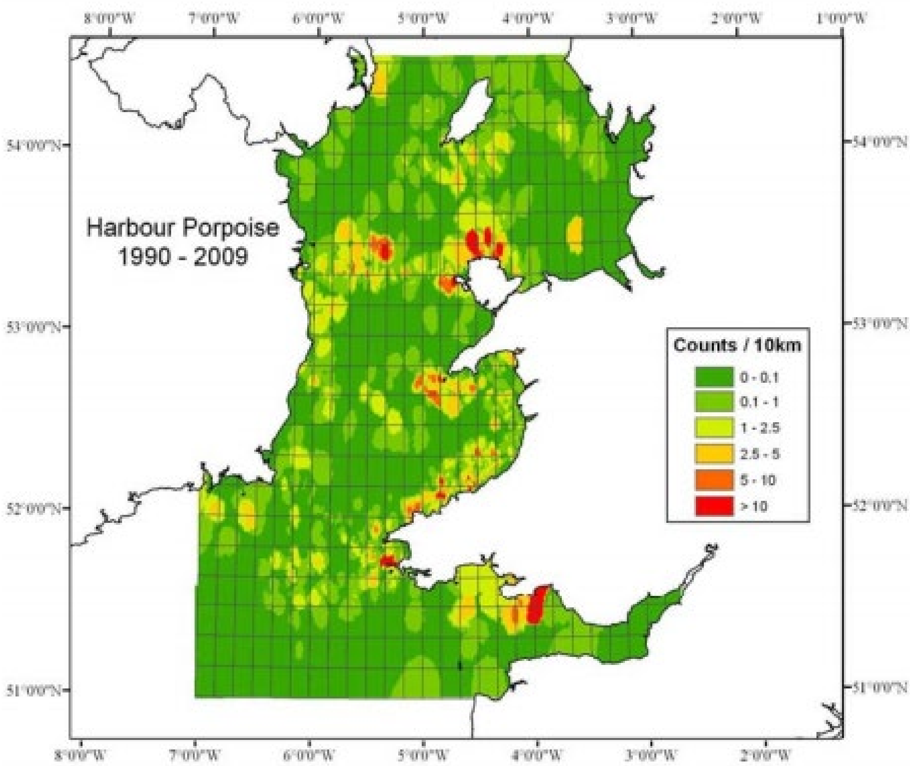


Figure 3-6 Long term sighting rates (vessel counts per 10km) of harbour porpoise



3.6 Otter

Otter (*Lutra lutra*) are semi-aquatic mammals which may inhabit rivers, lakes, coastal areas and marshy areas some distance from open water. Coastal populations utilise shallow, inshore marine areas for feeding but also require fresh water for bathing and terrestrial areas for resting and breeding holts. They are commonly seen foraging within a narrow zone close to the shore (<100m) and only rarely cover larger distances, moving between islands (DECC 2016).

Otter is listed on Annex II of the Habitats Directive and is a Qualifying Interest of the River Barrow and River Nore SAC. Otters are frequent throughout the SAC both on open coast and in the River Barrow waterway especially in areas where there is good access to the sea, sufficient tree and scrub cover and near streams where salt water can be washed off.

A review of existing National Biodiversity Data Centre records show that otter has been recorded in close proximity to sections of the Proposed Development at Baginbun Beach and in close proximity to the Great Island Power Station (Dixon.Brosnan 2019). An otter survey commissioned by GIL undertaken in 2018/2019 confirmed the presence of otters at both the Campile Estuary and Baginbun beach; signs of otter were recorded i.e. spraint (Figure 3-7) at Campile Estuary; a live otter was recorded during a bat survey at Dunbrody Bridge (Campile Estuary); and fresh otter tracks were noted along Baginbun Beach in March 2019. No holts or couches were recorded.

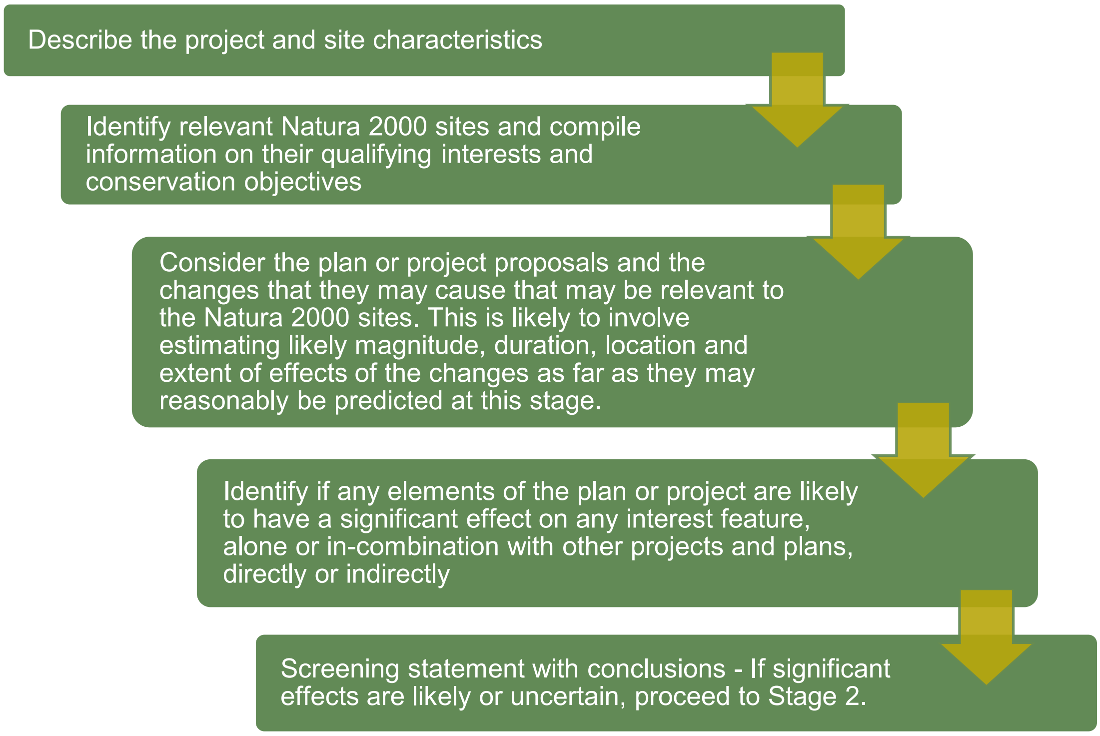
Figure 3-7 Locations of otter spraint along the Campile River Estuary.

4. Stage 1 – Appropriate Assessment Screening

4.1 Assessment Approach

This AA screening has been undertaken according to the process set out in the NPWS and DEHLG (2010) Guidance; following the process illustrated in Figure 4-1. It has taken into account all case law relevant to the Habitats Directive.

Figure 4-1 AA Screening



The structure for the remainder of this Section therefore reflects the key steps in this process.

4.2 Describe the project and site characteristics

A full description of the Proposed Development and Campile Estuary is provided in Section 2. The site characteristics i.e. the baseline environment associated with this AA screening, is described in Section 3.

4.3 Identification of relevant Natura 2000 sites (Screening)

The potential for a Natura 2000 site to be significantly affected depends on whether receptors which are Qualifying Interests of a Natura 2000 site:

a. Can come into contact with the Proposed Developments; and

b. Are sensitive to the Proposed Development activities to the extent that the activity is likely to have an adverse effect on the conservation objectives for the features.

Identifying relevant Natura 2000 sites has therefore been achieved by applying the following steps:

1. Identify which receptors could be sensitive to the Proposed Development and Campile Estuary (Section 4.3.1.1);
2. Identify the potential pressures the Proposed Development and Campile Estuary could have on these receptors and what the zone of influence for these receptors is, i.e. the spatial extent over which effects could extend (Section 4.3.1.2)
3. Using the zones of influence as a guide to define a search area within which Natura 2000 sites are screened for the relevant Qualifying Interests (Section 4.1.3.2); and
4. Screen SACs and SPAs within the defined search areas to identify Qualifying Interests and assess whether Qualifying Interests of the site could be significantly affected by the Proposed Development (Section 4.1.3.3).

4.3.1.1 Identification of sensitive receptors

The receptors which could potentially be affected by the Proposed Development and Campile Estuary and could be the Qualifying Interests of Natura 2000 sites are:

- Estuarine, intertidal and benthic habitats;
- Fish;
- Birds; and
- Marine mammals (cetacean, pinniped and otter).

A description of the existing baseline for these receptors is provided in Section 3 above.

4.3.1.2 Defining a search area (identification of potential pressures and zone of influence)

The OSPAR Intercessional Correspondence Group on Cumulative Effects (ICG-C) pressure list and descriptions (OSPAR Commission 2011) have been used to describe the potential pressures expected from the Proposed Development and Campile Estuary. Listed in Table 4-1, these potential pressures may be direct or indirect, temporary or permanent, beneficial or harmful to the site, or a combination of these. The zone of influence – spatial extent over which effects may extend – has also been defined.

Repair and maintenance activities during the operational phase, where required, will result in similar pressures to those described in respect to installation activities, but on a smaller and more local scale. Therefore, they have been considered alongside installation pressures.

The zone of influence has been used to establish a search area within which Natura 2000 sites are screened for the relevant Qualifying Interests. Since mobile species from Natura 2000 sites further field may travel into the zone of influence, the zone of influence cannot be used alone as a distance to screen in relevant conservation sites. Therefore, search areas (distances from the Proposed Development) for each receptor group have been applied taking into consideration other information such as marine mammal management units and expert judgement to use for the initial screening of sites. Justification for the spatial extent of the search area is provided in Table 4-1.

Table 4-2 identifies the pressures that have been scoped out of the NIS and the reason for the exclusion. These pressures will not be discussed further.

Table 4-1 Potential pressures, zones of influence and Natura 2000 search area

Receptor	Phase	Potential Pressure	Aspect of Proposed Development	Zone of influence	Search area and justification
Habitats	Installation (including repair & maintenance) Decommissioning	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Seabed preparation. Cable burial. Cable removal.	20m wide	Proposed Development Jetting and ploughing will result in a brief, localised sediment plume. Levels of suspended sediments will be rapidly dilute within the Proposed Development and will be within the range of natural variation experienced after winter storm events in the region.
			Anchor placement	Proposed Development	
		Siltation rate changes, including smothering (depth of vertical sediment overburden)	Cable burial. Cable removal.	100m wide	
		Hydrological changes (inshore/local)	External cable protection	Baginbun Beach	
		Physical change (to another seabed type)	External cable protection	10m wide	
Birds	Installation (including repair & maintenance) Decommissioning	Visual disturbance	Project vessels Irish Onshore works e.g. at HDD compounds (Baginbun Beach & Campile Estuary)	Radial distances 4km divers and sea ducks[+] 2km all other species[+]	10km It is recognised that some seabirds from other SPAs will forage and loaf in zone of influence. However, disturbance will be limited in extent and duration and there is sufficient space in the surrounding environment for birds to temporarily relocate. Therefore, only sites within 10km of the Proposed Development have been screened.
Fish	Installation (including repair & maintenance) Decommissioning	Underwater noise changes*	Continuous sound from geophysical survey	2.2km radial distance	40km Although the greatest zone of influence is 6.2km, there is the potential that underwater noise changes could also impede migration to and from rivers.
			Continuous sound from cable installation, cable removal and vessels	50m radial distance	

Receptor	Phase	Potential Pressure	Aspect of Proposed Development	Zone of influence	Search area and justification
			Impulsive sound - UXO detonation	6.2km radial distance	Therefore, the search area has been extended to 40km.
	Operation	Electromagnetic changes	Cables	2m radial distance	
Cetacean and otter	Installation (including repair & maintenance) Decommissioning	Underwater noise changes*	Continuous sound from geophysical survey	2.6km radial distance	Management Unit** In recognition of the highly mobile nature of cetaceans the relevant species management unit will define the search area.
			Continuous sound from cable installation, cable removal and vessels	130m radial distance	
			Impulsive sound - UXO detonation	54km radial distance	
	Operation	Electromagnetic changes	Cables	2m radial distance	
Pinniped	Installation (including repair & maintenance) Decommissioning	Underwater noise changes*	Continuous sound from geophysical survey	130m radial distance	100km grey seal It is estimated that grey seal forage up to 100km from their haul out sites (DECC 2016) 50km harbour seal Harbour seal are not known to make trips greater than 50km from haul out sites (DECC 2016)
			Continuous sound from cable installation, cable removal and vessels	2.6km radial distance	
			Impulsive sound - UXO detonation	54km radial distance	

* Zones of Influence for underwater noise changes have been taken from Appendix C – Underwater Sound Modelling (Intertek EWCS 2019).

** Most cetaceans are wide-ranging, and individuals encountered within Welsh waters form part of a much larger biological population whose range extends into adjacent jurisdictions. As a result, management units (MUs) have been outlined for seven of the common regularly occurring species following advice from the Sea Mammals Research Unit (DECC 2016) and the International Council for the Exploration of the Sea (ICES). These provide an indication of the spatial scales at which impacts of anthropogenic activities should be taken into consideration.

[+] Based on the extent and potential consequences of seabird displacement from offshore wind farm developments published by the UK Joint Statutory Nature Conservation Bodies (JNCC 2017).

Table 4-2 Pressures screened out and the reason for exclusion

Pressure Screened Out of EIA	Receptor	Reason for Exclusion
Hydrocarbon and PAH contamination	All receptors	Unplanned events (accidental oil or chemical spills) have been screened out of the assessment for the following reasons: • The majority of the Proposed Development lies within an area of low shipping density, crossing the main north to south West Celtic Sea shipping lane for a short distance perpendicular to the traffic flow. All project vessels will comply with Irish and International statute with respect to markings, communications and Collision Regulations. The risk of a collision leading to a large oil spill is therefore extremely low, and no greater than that for any other vessel in the region. This conclusion is supported by analysis of statistics from the Advisory Committee of Protection of the Sea (ACOPS) for the Bristol Channel and South Wales region for the period 2015 and 2016 (latest reports available) which shows that total incidents of mineral oil pollution averages 6 incidents per annum, representing 1% of the total number on the UK continental shelf. Of these incidents the majority were in ports and harbours rather than the open sea and consisted of bunkering type incidents from fishing vessels and pleasure craft. During the reporting period analysed offshore support vessels were involved in 14 of the 942 incidents (1.5%) reported on the UK continental shelf. • All project vessels will have control measures and shipboard oil pollution emergency plans (SOPEP) in place and will adhere to MARPOL Annex I requirements. • A Construction Environmental Management Plan and an Emergency Spill Response Plan will be developed and implemented. Execution of these plans will ensure that the risks associated with an unplanned event will be effectively managed in line with relevant international and national statute. In addition, the cables have been routed to avoid disturbing historically contaminated sediments (e.g. domestic or industrial waste, munitions) in disposal sites. No contaminated sediments were identified by the cable route survey (MMT 2019b). It is therefore unlikely that contaminated sediments will be resuspended or disturbed during cable installation.
Temperature changes - local	Habitats Fish	When cables are in operation, localised heating of the environment may occur surrounding the cables (i.e. sediments including interstitial water, where cables are buried, rock berms/concrete mattresses when cable protection employed). Seawater temperatures within the Celtic Sea vary seasonally and therefore are likely to accommodate minor localised variations in temperature associated with thermal losses. Effects on seabed temperature will be negligible. As there will be no significant effects on habitats there will be no significant effects on fish and shellfish.
Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)	Intertidal habitats	The preferred method of installation at the landfall is HDD. The HDD will exit below the low water mark and therefore intertidal habitats will not be affected and there will be no indirect effects on birds (e.g. temporary loss of food resource).

Pressure Screened Out of EIA	Receptor	Reason for Exclusion
	Intertidal birds	
Introduction or spread of non-indigenous species	Benthic habitats	The introduction of invasive non-native species (e.g. through discharge of ballast water from project vessels) will be managed under the International Convention for the Control and Management of Ship's Ballast Water and Sediments. Marine contractors engaged by GIL will be expected to complete a biosecurity risk assessment. This would include factors such as origins of the vessels and ensuring that relevant equipment is cleaned before use. Implementation of this legal requirement will reduce the pathways of effect and any effects will be Not Significant.
Visual disturbance	Fish	The pressure could occur during cable installation, as a result of the presence of the installation vessels and equipment (and associated noise). This could result in the displacement of fish within the water column. Fish will have reacted to underwater noise generated by project vessels before they react to the presence of the vessel. The disturbance from installation operations will be temporary, localised and not considered to be significant given existing background levels of noise and shipping in the St Georges Channel and around Waterford Estuary.
Siltation rate changes including smothering (depth of vertical sediment overburden)	Fish	There are three pathways for siltation rate changes to occur: through displacement of sediments during trenching; by the re-deposition of suspended sediment; and by external cable protection being placed on the seabed. Chapter 6 concluded that the significance of siltation rate changes is Imperceptible. The installation activities will increase the levels of suspended particular matter (SPM) in the water column. The magnitude of the increase will be dependent on the seabed conditions. Near the coast, between KP157 and 158, where a major component of the sediment is silt, a plume of 5km could be briefly generated from the trench - similar to suspended sediment concentrations during a storm. This will cloud the water, but as sediments are not contaminated it will not have a detrimental effect on the environment, and water clarity will quickly return as the installation moves on and tidal currents dissipate the suspended sediments. Calculations indicate the concentrations will be within the range of natural variability expected for the region, will be limited in extent and brief in nature. A temporary reduction in the feeding capability of species relying on sight to locate their prey may occur. Most species are likely to be tolerant to any changes in turbidity levels (equivalent to those experienced during storm events) and the significance of the effect is Not Significant.
Death or injury by collision	Marine mammals	Although shipping collision is a recognised cause of marine mammal and basking shark mortality worldwide, the key factor influencing the injury or mortality caused by collisions is ship size and speed. Ships travelling at 14 knots or faster are most likely to cause lethal or serious injuries. Although the presence of the cable lay vessels and support vessels will marginally increase the level of vessel activity within the area for the duration of the marine works, none of the project vessels will be travelling at speeds exceeding 14 knots. Cable lay vessels move along the cable route at the rate of cable installation, approximately 100-300m per hour (0.05 – 0.16 knots) depending on sediment

Pressure Screened Out of EIA	Receptor	Reason for Exclusion
		conditions, resulting in a low likelihood of collision. Given that vessels will be operating at less than 14 knots, the pressure is not considered further.

4.3.1.3 Screening of Natura 2000 sites

A geographic information system (GIS) was used to map the boundaries of SACs and SPAs in relation to the Proposed Development and Campile Estuary. All SACs and SPAs which are within the search areas outlined in Table 4-1 have been screened for relevant Qualifying Interests. There are no candidate SACs (cSACs) within the search area.

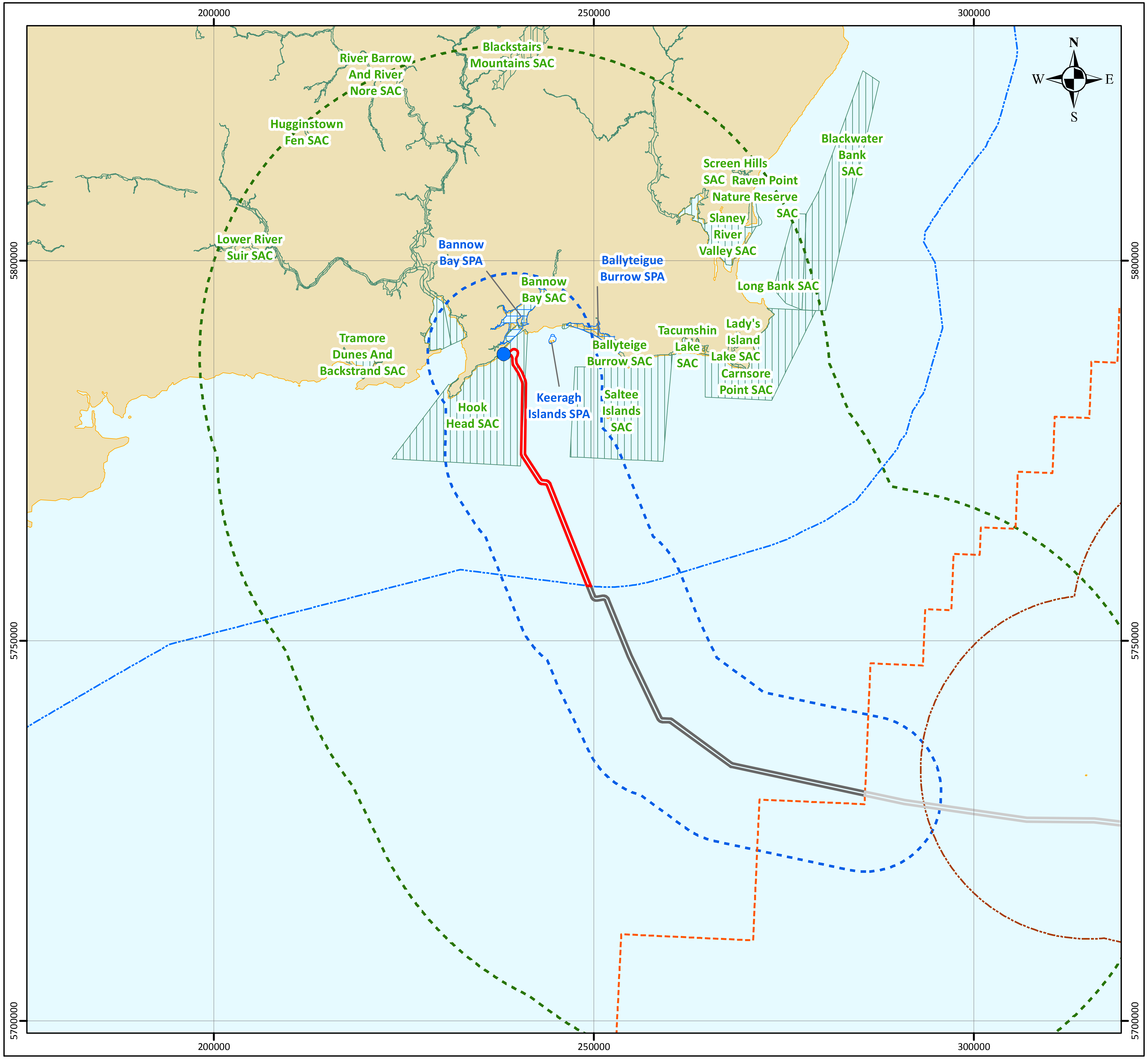
A total of 16 sites were screened in this assessment and are shown in Table 4-3 and Figure 4-1 (Drawing P1975-PROT-004) and Figure 4-2 (Drawing P1975-PROT-005).

For each site it was determined whether there is the potential for an interaction between the Proposed Development and the Qualifying Interest i.e. whether there is a pressure-receptor pathway. This is determined by comparing information such as the zone of influence with information regarding the Qualifying Interests e.g. species foraging distances, spatial extent of habitats etc. The interactions were defined as follows:

- Yes: A pathway between the Proposed Development and the Qualifying Interest can be identified that is likely to result in an effect; or
- No: Either a pathway between the Proposed Development and the Qualifying Interest cannot be established; or a pathway exists but there is no physical overlap of the pressure and the Qualifying Interest.

For all Qualifying Interests where it is determined that there is a pathway, the likely significance of the effect is assessed in light of the conservation objectives for the site in Section 4.4.

For all Qualifying Interests where it is determined that there is no pathway, the Qualifying Interest has been screened out from further assessment.



GREENLINK INTERCONNECTOR

PROTECTED SITES 1

Drawing No: P1975-PROT-004	A

Legend

- Baginbun Beach
- Proposed Development
- Irish Offshore
- Wales Marine

Qualifying Interest Search Area

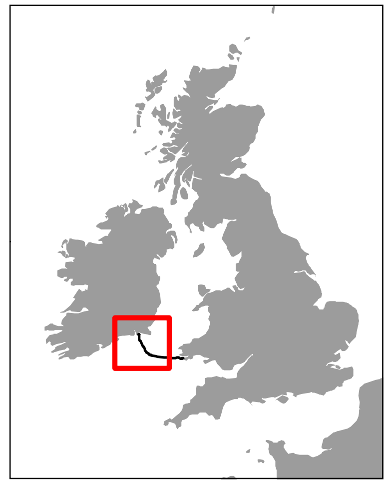
- 10km - Birds
- 40km - Fish

Administrative Boundaries

- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line

Environmental Designations

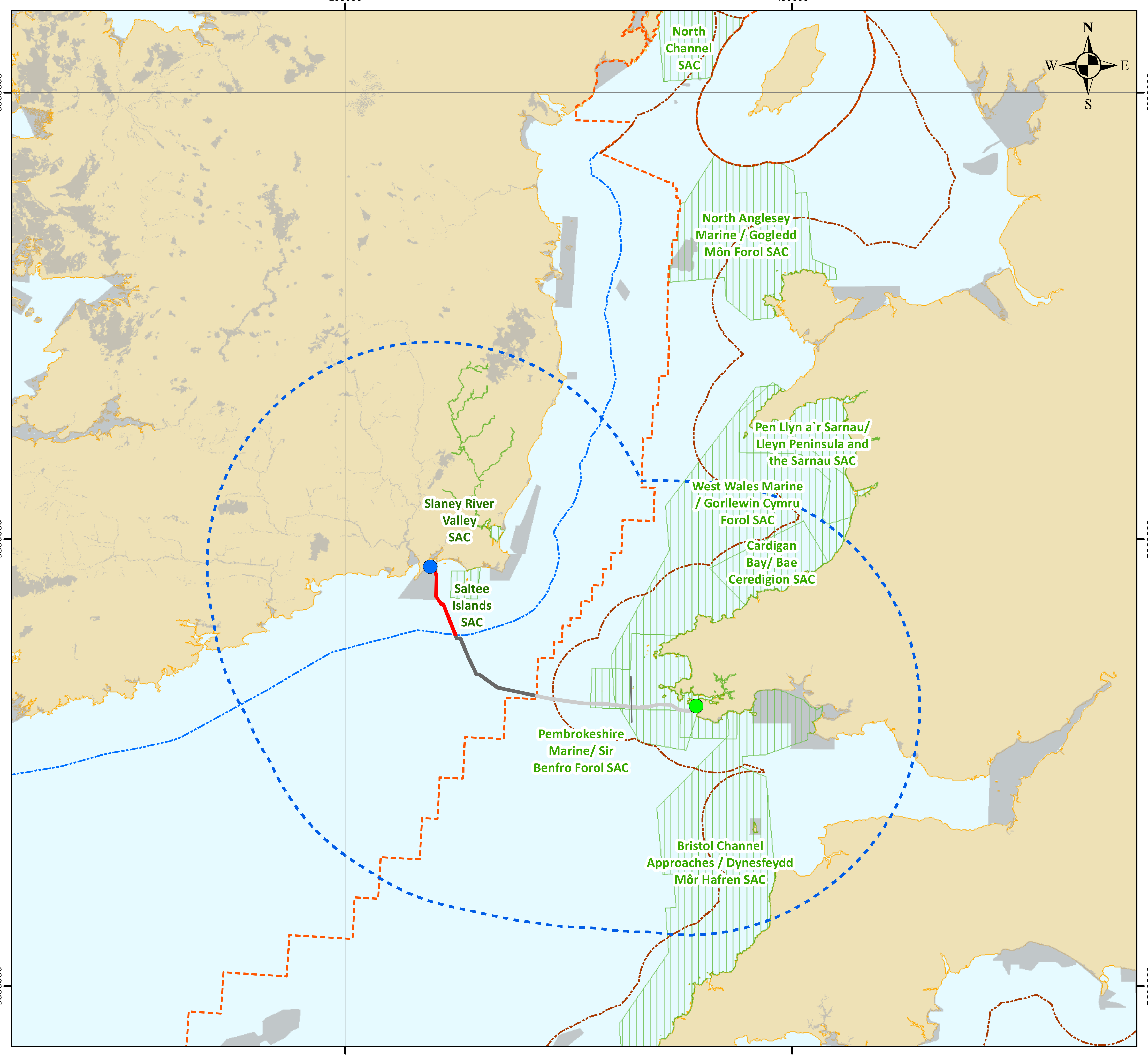
- SAC
- SPA



Date	Thursday, July 11, 2019 09:03:40
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; NPWS; GEBCO; Greenlink
File Reference	J:\P1975\Mxd\08_PROT\ P1975-PROT-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union Connecting Europe Facility

0 5 10 15 20 km



GREENLINK INTERCONNECTOR

PROTECTED SITES 2

Drawing No: P1975-PROT-005 | **A**

Legend

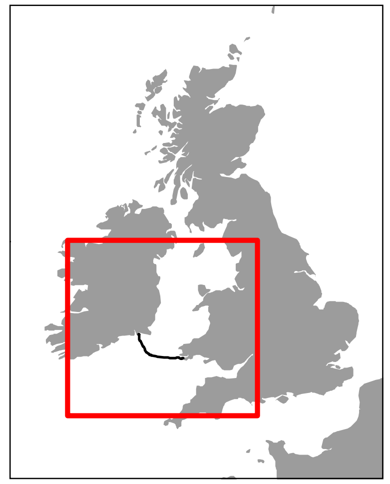
- Baginbun Beach
- Freshwater West
- Proposed Development
- Irish Offshore
- Wales Marine
- 100km Search Area

Administrative Boundaries

- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line

Environmental Designations

- Marine Mammal SAC
- Non-Marine Mammal SAC



Date	Thursday, July 11, 2019 16:46:37
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; JNCC; NPWS; GEBCO; Greenlink
File Reference	J:\P1975\Mxd\08_PROT\ P1975-PROT-005.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 20 40 60 80 km

Table 4-3 Initial screening of relevant Natura 2000 sites

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
Hook Head SAC - IE0000764	• Large shallow inlets and bays	Within	Penetration and/or disturbance including abrasion	**Yes** - There is the potential for a likely significant effect on benthic habitats from seabed preparation, cable burial and cable burial.	Screened IN
			Siltation rate changes	**Yes** - Seabed preparation, cable burial and cable removal will cause a brief, localised increase in suspended sediment in the water column with subsequent re-deposition of sediment on surrounding habitats. Sessile and less mobile epifauna and infauna in surface sediments are most likely to be affected.	Screened IN
			Physical change (to another seabed type)	**Yes** - External cable protection has the potential to permanently change the benthic habitat.	Screened IN
			Hydrological changes (inshore/local)	**Yes** - External cable protection has the potential to effect sediment transport pathways to Baginbun Beach.	Screened IN
	• Reefs		Penetration and/or disturbance including abrasion	**Yes** - There is the potential for a likely significant effect on benthic habitats from seabed preparation, cable burial and cable burial.	Screened IN
			Siltation rate changes	**Yes** - Seabed preparation, cable burial and cable removal will cause a brief, localised increase in suspended sediment in the water column with subsequent re-deposition of sediment on surrounding habitats. Sessile and less mobile epifauna and infauna in surface sediments are most likely to be affected.	Screened IN
			Physical change (to another seabed type)	**Yes** - external cable protection in areas of Annex l reef has the potential to permanently change the habitat.	Screened IN

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Vegetated sea cliffs of the Atlantic and Baltic coasts • (NPWS 2013b)		No pressure-receptor pathway identified	**No -** Proposed Development will not interact with the Qualifying Interest, therefore there is no likelihood of significant effects.	Screened OUT
River Barrow and River Nore SAC-IE0002162	• Estuaries • Mudflats and sandflats not covered by seawater at low tide • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadows (Glauco-Puccinellietalia maritimae), • Mediterranean salt meadows (*Juncetalia maritimi*),	Within	Penetration and/or disturbance including abrasion	**No** - Campile Estuary crossing will be made via horizontal directional drill and therefore will not interact with the Qualifying Interests.	Screened OUT
	• Nore freshwater pearl mussel (*Margaritifera durrovensis*), • Desmoulin's whorl snail (*Vertigo moulinsiana*), • Freshwater pearl mussel (Margaritifera margaritifera), • White-clawed crayfish (Austropotamobius pallipes),		No pressure-receptor pathway identified	**No -** Campile Estuary will not interact with the Qualifying Interests.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Killarney fern Trichomanes speciosum • Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation • European dry heaths, Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, Petrifying springs with tufa formation (Cratoneurion) • Old sessile oak woods with Ilex and Blechnum in the British Isles • Alluvial forests with Alnus glutinosa and Fraxinus excelsior Alno-Padion, Alnion incanae, Salicion albae.		No pressure-receptor pathway identified	**No -** Campile Estuary will not interact with the Qualifying Interests.	Screened OUT
	• Otter Lutra lutra		Disturbance	**Yes** - Known to be present at Baginbun Beach and Campile Estuary.	Screened IN
	• Brook lamprey Lampetra planeri		No pressure-receptor pathway	**No -** Qualifying Interest will not be present in the Proposed Development.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Twaite shad *Alosa fallax* • Atlantic salmon (*Salmo salar*) (only in fresh water)		Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	**Screened IN**
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	Screened OUT
	• River lamprey Lampetra fluviatilis • Sea lamprey Petromyzon marinus		Underwater noise changes	**No** - Sea and river lamprey are not hearing specialist fish species and it is unlikely that they will be effected by underwater noise changes.	Screened OUT
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	Screened OUT
Saltee Islands SAC-IE0000707	• Tidal Mudflats and Sandflats • Large Shallow Inlets and Bays • Reefs	6.1km	Penetration and/or disturbance including abrasion. Siltation rate changes.	**No** - pressure zones of influence do not overlap with the site.	Screened OUT
	• Vegetated Sea Cliffs, • Sea Caves		No pressure-receptor pathway identified	**No** - the Proposed Development will not interact with the Qualifying Interests.	Screened OUT
	• Grey Seal (Halichoerus grypus)		Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Visual disturbance	**No** - Given the distance (6.1km) of this SAC from cable installation activities, seals will not be visually disturbed.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
Lower River Suir SAC - IE0002137	• Hydrophilous Tall Herb Communities, • Old Oak Woodlands, • Alluvial Forests, • Yew Woodlands	18km	No pressure-receptor pathway identified	**No -** the Proposed Development will not interact with the Qualifying Interests.	Screened OUT
	• Atlantic Salt Meadows (Glaco-Puccinelliertalia maritimae), • Mediterranean Salt Meadows (*Juncetalia maritimi*), • Floating River Vegetation, • Freshwater Pearl Mussel (*Margaritifera margaritifera*), • White-clawed Crayfish (*Austropotamobius pallipes*),		Penetration and/or disturbance including abrasion. Siltation rate changes.	**No -** pressure zones of influence do not overlap with the site.	Screened OUT
	• Otter (Lutra lutra) • Brook Lamprey (*Lampetra planeri*),		Disturbance	**No -** the Proposed Development will not interact with the Qualifying Interests.	Screened OUT
	• Twaite Shad (*Alosa fallax*), • Atlantic Salmon (*Salmo salar*)		Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	**Screened OUT**

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• River Lamprey (*Lampetra fluviatilis*), • Sea Lamprey (Petromyzon marinus),		Underwater noise changes	**No** - Sea and river lamprey are not hearing specialist fish species and it is unlikely that they will be effected by underwater noise changes.	**Screened OUT**
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	**Screened OUT**
Slaney River Valley SAC - IE0000781	• Estuaries, • Mudflats and sandflats not covered by seawater at low tide.	29.7km	Penetration and/or disturbance including abrasion. Siltation rate changes.	**No -** pressure zones of influence do not overlap with the site.	Screened OUT
	• Atlantic salt meadows (Glauco-Puccinellietalia maritimae), • Mediterranean salt meadows (*Juncetalia maritimi*), • Freshwater pearl mussels (*Margaritifera margaritifera*). • Brook Lamprey (*Lampetra planeri*),		No pressure-receptor pathway identified	**No -** the Proposed Development will not interact with the Qualifying Interests.	Screened OUT
	• Otter (*Lutra lutra*).		Disturbance	**No -** the Proposed Development will not interact with the Qualifying Interest.	Screened OUT
	• Twaite Shad (*Alosa fallax*),		Underwater sound changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Atlantic Salmon (*Salmo salar*).		Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	**Screened OUT**
	• Sea Lamprey (Petromyzon marinus), • River Lamprey (Lampetra fluviatilis),		Underwater noise changes	**No** - Sea and river lamprey are not hearing specialist fish species and it is unlikely that they will be effected by underwater noise changes.	**Screened OUT**
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	**Screened OUT**
	• Harbour seal (*Phoca vitulina*)		Underwater sound changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Visual disturbance	**Unlikely** - Given the distance (6.1km) of this SAC from cable installation activities, seals will not be visually disturbed.	Screened OUT
Bannow Bay SPA - IE0004033	Wintering birds: • Light-bellied Brent goose (*Branta bernicla hrota*), • Shelduck (*Tadorna tadorna*)), • Pintail (*Anas acuta*), • Oystercatcher (Haematopus ostralegus), • Golden plover (*Pluvialis apricaria*), • Grey plover (Pluvialis squatarola),	1.6km	Visual disturbance	**Yes** - it is possible that wintering birds from this site could be disturbed by the Proposed Development.	Screened IN

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Lapwing (Vanellus vanellus), • Knot (Calidris canutus), • Dunlin (Calidris alpina), • Black-tailed godwit (*Limosa limosa*), • Bar-tailed godwit (*Limosa lapponica*), • Curlew (Numenius arquata), • Redshank (Tringa totanus) • Wetlands				
Saltee Islands SPA - IE000707)	Breeding seabirds: • Fulmar (Fulmarus glacialis), • Gannet (Morus bassanus), • Cormorant (Phalacrocorax carbo), • Shag (Phalacrocorax aristotelis); • Lesser black-backed gull (*Larus fuscus*); • Herring gull (*Larus argentatus*); • Kittiwake (Rissa tridactyla);	10km	Visual disturbance	**No** - The zone of influence for visual disturbance is between 2-4km for the bird species identified (as some are classified as divers). Given the 10km distance to this site, birds species within the site will not experience visual disturbance. Although some of these bird species may be observed feeding and loafing in the Proposed Development they will be able to forage over the wider area and therefore will be unaffected.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Guillemot (*Uria aalge*); • Razorbill (*Alca torda*); • Puffin (Fratercula arctica).				
Ballyteige Burrow SPA - IE004020	• Light-bellied brent goose (*Branta bernicla hrota*), • Golden plover (*Pluvialis apricaria*), • Grey plover (Pluvialis apricaria), • Lapwing (Vanellus vanellus), • Shelduck (Tadorna tadorna), • Black-tailed godwit (*Limosa limosa*), • Bar-tailed godwit (*Limosa lapponica*), • Wetland and waterbirds	8.1km	No pressure-receptor pathway identified	**No** - Qualifying Interest bird species are all intertidal and therefore not within the zone of influence.	Screened OUT
Keeragh Islands SPA - IE004118	• Cormorant (Phalacrocorax carbo)	4.5km	Visual disturbance	**No -** cormorant are classed as divers and therefore the zone of influence for this species is 4km. Given the distance to the site birds may be observed feeding and loafing in the Proposed Development but they will be able to forage over the wider area and therefore will be unaffected.	Screened OUT
UK Waters					
Pembrokeshire Marine/ Sir	• Estuaries	24.3km	Penetration and/or disturbance including abrasion	**No-** site is outside of the search area for habitats.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
Benfro Forol SAC UK0013116	• Large shallow inlets and bays • Reefs • Shore dock (*Rumex rupestris*)		Siltation rate changes		
	• Grey Seal (Halichoerus grypus)		Underwater sound changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Visual disturbance	**No** - The distance given is from Irish Offshore to the site. Animals from the site may travel into the Proposed Development but it is unlikely to be in any large numbers. The Welsh Marine component of Greenlink crosses the site and the site has been screened for likely significant effects in the Greenlink Marine Habitats Regulation Assessment (HRA) - Wales. As a linear project activity will move sequentially along the cable route and will not occur simultaneously in more than one area. Therefore it is unlikely that there will be intra-project cumulative effects on grey seal.	Screened OUT
West Wales Marine / Gorllewin Cymru Forol SAC - UK0030397	• Harbour porpoise (*Phocoena phocoena*) Site is within the Celtic and Irish Seas (CIS) Management Unit	35km	Underwater sound changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration to or from rivers.	Screened OUT
Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau SAC - UK0013117	• Sandbanks which are slightly covered by sea water all the time • Estuaries • Coastal lagoons • Large shallow inlets and bays	150.5km	Penetration and/or disturbance including abrasion Siltation rate changes	**No -** site is outside of the search area for habitats.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Reefs • Mudflats and sandflats not covered by seawater at low tide • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadows (Glauco-Puccinellietalia maritimae) • Submerged or partially submerged sea caves				
	• Otter (Lutra lutra) • Grey seal (Halichoerus grypus),		Underwater sound changes Visual disturbance	**No** site is outside of the search area for these species.	Screened OUT
	• Bottlenose dolphin (*Tursiops truncatus*)		Underwater sound changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration.	Screened OUT
Cardigan Bay/ Bae Ceredigion SAC - UK0012712	• Bottlenose dolphin (*Tursiops truncatus*) Site is within the Offshore Channel and SW England (OCSW) Management Unit	96.3km	Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration.	Screened OUT

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
	• Sea lamprey (Petromyzon marinus) • River lamprey (Lampetra fluviatilis) • Grey seal (Halichoerus grypus)		Underwater noise changes	**No -** site is outside of the search area for fish species and at the very limit of grey seal foraging range.	Screened OUT
	• Sandbanks which are slightly covered by sea water all the time • Reefs • Submerged or partially submerged sea caves		No pressure-receptor pathway	**No -** site is outside of the search area for habitats.	Screened OUT
Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC - UK0030396	• Harbour porpoise (*Phocoena phocoena*) Site is within the Celtic and Irish Seas (CIS) Management Unit	73.3km	Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration.	Screened OUT
North Anglesey Marine / Gogledd Môn Forol SAC - UK0030398	• Harbour porpoise (*Phocoena phocoena*) Site is within the Celtic and Irish Seas (CIS) Management Unit	179km	Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN
			Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration.	Screened OUT
	• Harbour porpoise (*Phocoena phocoena*)	260km	Underwater noise changes	**Yes** - Appendix C concluded that underwater noise could cause temporary injury or disturbance.	Screened IN

Site Name & code	Qualifying Interests	Distance*	Potential Pressures	Potential for pressure-receptor pathway	Conclusion
North Channel SAC - UK0030399	Site is within the Celtic and Irish Seas (CIS) Management Unit		Electromagnetic changes	**No** - effects of EMF will be not be measurable above natural background levels within 2m of bundled cables. A slight elevation will be noticeable within 10m of the HDD exit but due to its position it will not inhibit migration.	Screened OUT
* Direct from Proposed Development, Campile Estuary or Irish Offshore (whichever is closest). **Sources:** NPWS (2012), NPWS (2013), NPWS (2014a,b,c), NPWS (2015), NPWS (2016a), NPWS (2017), JNCC (2019a,b,c,d,e,f,g)					

4.4 Assessment of Likely Significant Effects

A likely effect is defined as one that cannot be ruled out on the basis of objective information. The test is a 'likelihood' of effects rather than a 'certainty' of effects. Where the Proposed Development is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on the site. The assessment of that risk must be made in the light, amongst other things, of the characteristics and specific environmental conditions of the site concerned. If Table 4-3 identified that an interaction between the Proposed Development and the Qualifying Interest is possible, the potential for a likely significant effect on the conservation objectives has been considered in the sections below.

4.4.1 Hook Head SAC

4.4.1.1 Conservation objectives

Reef

To maintain the favourable conservation condition of Reefs in Hook Head SAC, which is defined by the following list of attributes and targets:

- Distribution: The distribution of reefs should remain stable, subject to natural processes.
- Habitat area: The permanent area is stable, subject to natural processes.
- Community Structure: The following reef community complexes should be maintained in a natural condition: Exposed to moderately exposed intertidal reef community complex; and Echinoderm and sponge dominated community complex.
- Community extent: The extent of Laminaria dominated community should be conserved, subject to natural processes.
- Community structure: The biology of Laminaria dominated community should be conserved, subject to natural processes.

Large shallow inlets and bays

To maintain the favourable conservation condition of large shallow inlets and bays in Hook Head SAC, which is defined by the following list of attributes and targets:

- Habitat area: The permanent area is stable, subject to natural processes.
- Community extent: The following communities should be maintained in a natural condition: Sand with *Chaetozone christiei* and *Tellina* sp. community; and Coarse sediment with *Pisidia longicornis* and epibenthic fauna community complex.

4.4.1.2 Assessment against conservation objectives - Reef

A pressure-receptor pathway has been identified between three pressures and the Qualifying Interest. These are:

- Penetration and/or disturbance including abrasion
- Siltation rate changes
- Physical change (to another seabed type)

These pressures are considered in turn below, recognising that individually a pressure may not lead to a significant effect but combined, effects could accumulate significantly.

The extent of Annex I Reef habitat within the Proposed Development is calculated as 5.33km^2 of which 4.16km^2 is within the Hook Head SAC.

There are two potential areas where Annex I Bedrock Reef habitat could be effected by the Proposed Development:

- Offshore cable installation - Bedrock Reef is present within the Proposed Development therefore there is a risk that installation activities could effect this habitat. The potential for likely significant effects from this activity is discussed below.
- HDD exit point: The design is to HDD under the beach to an exit point past the 9m water depth contour, avoiding the area of fringing Bedrock Reef in the intertidal zone and removing the pressure-receptor pathway. The HDD exit has been designed post survey using habitat maps and has been positioned to avoid interaction with bedrock reef. Therefore, direct effects on the fringing Bedrock Reef have been screened out as there is no pathway for interaction and there will be no significant effects.

Offshore the Bedrock Reef is classified as EUNIS habitat A3.11 - Kelp with cushion fauna and/or foliose red seaweeds. The presence and location of the Annex I habitat offshore was taken into consideration during the design (routeing) of the Proposed Development. INFOMAR bathymetry data and NPWS habitat maps were used to identify a suitable cable route through the Hook Head SAC that avoids crossing the Annex I habitat (Table 2-2). Route engineering was undertaken during the marine survey to investigate options to further avoid outcropping rock features. This has led to the selection of the final route, shown as the indicative centreline within the Proposed Development. The worst case scenario is that the cables are laid across the Annex I habitat. This scenario is- technically challenging due to the ground conditions, will require extensive external cable protection and will significantly increase installation costs. If this scenario had been considered the only viable method of installing the cables the route to Baginbun Beach would not have been selected. The Proposed Development (the design assessed) is therefore an installation corridor that avoids crossing the Annex I bedrock reef habitat offshore. The channel between the mapped Annex I habitat features is sufficiently wide to allow installation within the sandy sediments.

Although the Proposed Development will avoid the Bedrock Reef habitat through routeing it is acknowledged that the extent of the Proposed Development has not been refined to exclude the habitat from the application area. Screening for likely significant effects is undertaken prior to any mitigation being proposed and therefore as Bedrock Reef is present within the Proposed Development there is still a risk that during installation activities that penetrate and/or disturb the habitat could be undertaken. Intrusive activities e.g. cable trenching have the potential to reduce the extent of the habitat and affect the community structure.

Jetting or plough trenching will be used to install the cables within the sand channel. These installation activities will cause a brief, temporary increase in suspended sediments. Jet trenching will cause a greater level of sediment suspension compared to the use of ploughing equipment.

Although modern equipment and installation techniques have reduced the re-suspension of sediment during cable trenching activities, remaining suspended sediment dispersed into the water column have the potential to affect sessile filter feeders and, once settled out, could potentially smother organisms within the deposition area.

Each metre of trench will result in a displacement of 1.5m^3 of sediment, with between 80% (jetting) and 95% (ploughing) returned to the trench – the remainder being released into the water column. The sediment will settle out of suspension over varying distances depending on particle size. Calculations based on terminal settling velocities of particles combined with the average seabed currents (0.7m/s) and assuming a release point 5m above the seabed indicate that gravel will settle out rapidly within 2m of the trench. Sand will form a fine layer up to 1.6cm thick within 19m of the trench and silt will travel further (up to 5.3km but the thickness of the layer will be unnoticeable (less than 1mm thick).

Dilution calculations indicate that the average suspended particulate matter (SPM) concentration will reach 300mg/l within 100m of the trench, but will rapidly dissipate with distance and time (within hours).

Measurements commissioned by the Waterford Port Company at a disposal site in the mouth of the River Barrow indicated background SPM concentrations were low; between 5mg/l at neap tide and 19 mg/l on spring tide during June 1999 (Delft 2000). However, elevated concentrations of suspended sediments are commonplace in shallower, higher energy environments, e.g. shallow circalittoral sand biotopes, especially during and following storm events. The Co.Wexford coastline experiences seasonal fluctuations in turbidity, related to storm conditions. This is evident from photographs taken during the benthic survey (October 2018) showing high suspended sediment loads in the water column (Figure 4-3); potentially greater than 100mg/l and up to 1000mg/l, although this was not measured and is based on comparison of the image with samples showing known concentrations of SPM.

Figure 4-4 Photographs taken during cable route survey showing high levels of turbidity

Source: MMT (2019)

The Marine Life Information Network (MarLIN) classified a similar habitat to EUNIS habitat A3.11 (A3.113) as not sensitive and highly resilient to smothering and siltation rate changes. It is therefore concluded that the Annex I bedrock reef habitat will not be significantly affected by brief, localised siltation rate changes.

Screening Conclusion: Likely Significant Effects cannot be ruled out. Appropriate Assessment is required.

4.4.1.3 Assessment against conservation objectives – large shallow inlets and bays

The NATURA 2000 data form states that this habitat covers 52.44km^2 (5243.84 hectares) of the site.

This habitat is a mosaic of both intertidal and subtidal habitats and includes areas of Bedrock Reef. The habitats identified with the Proposed Development that fall within this category are listed in Table 4-4 below. Using information provided on MarLIN (2019), Table 4-4 presents an assessment of the sensitivity of the habitats to the pressure penetration and/or disturbance, including abrasion.

Table 4-4 Sensitivity of habitats to the pressure penetration and/or disturbance including abrasion

EUNIS habitat code	Resistance	Resilience	Sensitivity	Confidence *			
				Q	A	C	Overall
A3.11 - Kelp with cushion fauna and/or foliose red seaweeds	Low	Medium	Medium	H	H	H	High
A3.2 – Atlantic and Mediterranean moderate energy infralittoral rock	Low	Very Low	High	L	L	L	Low
A5.14 - Circalittoral coarse sediment	Medium	Medium	Medium	L	L	L	Low
A5.23 – Infralittoral fine sand	None	Medium	Medium	H	H	H	High
A5.24 - Infralittoral muddy sand	Medium	High	Low	M	M	M	Medium

EUNIS habitat code	Resistance	Resilience	Sensitivity	Confidence *			
				Q	A	C	Overall
A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	Medium	High	Low	H	H	M	High - medium
A5.25 - Circalittoral fine sand	Medium	High	Low	H	H	M	High - medium
A5.252 - *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	Medium	High	Low	H	H	M	High - medium
A5.44 - Circalittoral mixed sediments	Low	Low	High	H	H	M	High - medium
Notes * specific to sensitivity Italics & grey = Assessment based on sublevel habitat assessments Q = Quality of Evidence; A = Applicability of Evidence; C = Degree of concordance (agreement between studies); L = Low; M = Medium; H = High							

The assessment for A5.44 is based on the EUNIS sub-level habitat A5.442 - Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment, as this is the only EUNIS sub-level habitat that has been assessed by MarLIN. The two featured species of the habitat are particularly sensitive to activities which cause abrasion and disturbance; *Cerianthus lloydii* is a tube-dwelling anemone, whilst *Modiolus modiolus* (blue mussel) are large, sessile and shallowly buried individuals unable to escape from activities which penetrate the seabed. The habitat A5.44 was identified within the Hook Head SAC between KP156 and KP158. It was sampled by one grab sample (S01). The grab sample consisted mainly of sand (60%) and was classified as gravelly muddy sand. The infaunal analysis showed a small sample with regards to abundance and diversity which was primarily characterised by crustaceans and polychaetes. The species identified in the grab included the polychaetes *Sclerocheilus*, *Scolelepis korsuni*, *Parexogone hebes*, *Magelona johnstoni*, and *Heteroclymene robusta*; and the echinoderm *Echinocyamus pusillus*. The low abundance and diversity from the grab, suggests that the sensitivity category of high is over conservative for the habitat identified. Given the species identified, which are not as sensitive to abrasion as *Modiolus modiolus* and *Cerianthus lloydii*, and the low abundance and diversity confirmed by the grab sample, the sensitivity is assessed as low.

Habitat A3.2 is associated with the Bedrock reef in the nearshore area of the Proposed Development. The high sensitivity classification for this habitat is appropriate and it is covered by the assessment of conservation objectives for Reef habitat above.

The sandy habitats identified in the Proposed Development are characteristic of moderately strong tidal currents, and given the dominance of sand and coarse sediments, are viewed as adaptable to physical disturbance. Many infaunal species live at depths where they will be protected from surface disturbance and in areas where direct loss occurs, adjacent areas will act to replenish communities rapidly as most infaunal species are mobile and the zone of influence is narrow. Bivalves and gastropods take longer than polychaetes to re-colonise areas but even considering this it is unlikely to exceed months (MarLIN 2019).

The zone of influence of the installation (15m wide) represents a very small area (0.12km^2) when compared to the extent of the habitat in the site (52.44km^2). Bundling the cable together supports this by ensuring that the cables share a trench, reducing the seabed footprint of installation.

The Proposed Development will temporarily effect 0.22% of the Qualifying Interest. However, it will not change the physical characteristics of the seabed, meaning that once installation activities have ceased the seabed will still be suitable for recolonization from the surrounding area. Habitats will be disturbed twice by two separate activities; cable route clearance and cable installation. The latter activity, cable installation will be the more significant of the two and will be a one-off event that will not be repeated. Siltation rates changes associated with installation will be brief and localised; a thin layer (2cm) of sand could be expected within 19m of the trench. This will not lead to any significant effects on habitats identified.

The Project Description includes a contingency for the deposit of a small volume of external cable protection at the two HDD exit points (likely to be in the form of two rock berms, both circa. 20m long by 5.2m wide). Where external cable protection is used the seabed habitat within the footprint of the external cable protection will be lost and replaced with harder substrate, changing the seabed type. The MarLIN sensitivity assessment concludes that for all habitat types the sensitivity to the pressure physical change (to another seabed type) is high. This is based on the fact that a change to an artificial or rock substratum will alter the character of the biotope leading to reclassification. The deposition of external cable protection in the nearshore area has the potential to reduce the community extent. A reduction in community extent can lead to a significant adverse effect on the conservation objectives of the Qualifying Interest.

Screening Conclusion: Likely Significant Effects cannot be ruled out. Appropriate Assessment is required.

4.4.2 River Barrow and River Nore SAC – Otter

4.4.2.1 Conservation objectives

Otter

To restore the favourable conservation condition of Otter in the River Barrow and River Nore SAC, which is defined by the following list of attributes and targets:

- Distribution – no significant decline,

- Extent of terrestrial habitat - No significant decline. Area mapped and calculated as 122.8ha above high water mark (HWM); 1136.0ha along river banks / around ponds,
- Extent of marine habitat - No significant decline. Area mapped and calculated as 857.7ha,
- Extent of freshwater (lake) habitat - No significant decline. Area mapped and calculated as 2.6ha,
- Couching sites and holts - No significant decline, and
- Fish biomass available - No significant decline.

4.4.2.2 Assessment against conservation objectives – Otter

The Campile Estuary component of Greenlink is within the River Barrow and River Nore SAC. The 2018/2019 otter survey recorded: otter at Dunbrody Bridge, fresh otter tracks at Baginbun Beach and signs of otter i.e. spraint along the Campile River. However, the survey did not record holts or couches. Based on this information, the chance of significant numbers of otter using the area is considered remote.

At the Campile Estuary, the work compounds are set back from the river and works will not cause habitat loss or degradation. Any disturbance of otter will be localised, temporary and minor in nature and will not affect the species in the short-term.

Screening conclusion: No potential for significant effects / AA is not required

4.4.3 River Barrow and River Nore SAC, Lower River Suir SAC and Slaney River Valley SAC – Twaite shad and Atlantic Salmon

Table 4-3 concluded that it was possible the underwater noise changes could cause injury or disturbance to twaite shad and Atlantic salmon. These species are Qualifying Interests for the River Barrow and River Nore SAC, Lower River Suir SAC and Slaney River Valley SAC. As the conservation objectives for the species are the same within each site they have been assessed together.

4.4.3.1 Conservation objectives

Twaite shad
To restore the favourable conservation condition of twaite shad in the sites, which is defined by the following list of attributes and targets:

- Distribution: extent of anadromy - greater than 75% of main stem length of rivers accessible from estuary,
- Population structure: age classes - more than one age class present,

- Extent and distribution of spawning habitat - No decline in extent and distribution of spawning habitats,
- Water quality: oxygen levels – no lower than 5mg/l, and
- Spawning habitat quality: Filamentous algae; macrophytes; sediment - Maintain stable gravel substrate with very little fine material, free of filamentous algal (macroalgae) growth and macrophyte (rooted higher plants) growth.

Atlantic salmon
To restore the favourable conservation condition of Atlantic salmon in the sites, which is defined by the following list of attributes and targets:

- Distribution: extent of anadromy - 100% of river channels down to second order accessible from estuary,
- Adult spawning fish Number - Conservation Limit (CL) for each system consistently exceeded,
- Salmon fry abundance - Maintain or exceed 0+ fry mean catchment-wide abundance threshold value currently set at 17 salmon fry/5 min sampling,
- Out-migrating smolt abundance - No significant decline,
- Number and distribution of redds - No decline in number and distribution of spawning redds due to anthropogenic causes, and
- Water quality - At least Q4 at all sites sampled by Environmental Protection Agency (EPA).

The conservation objectives only apply to Atlantic salmon in freshwater. However, in recognition that salmon is migratory species, an assessment of Atlantic salmon from this site has been provided below.

4.4.3.2 Assessment against conservation objectives

The ability of fish to hear noise is dependent on their hearing structures, which indicate their sensitivity to sound. Sound pressure is only detected by those species possessing a swim bladder; the otolith organ acts as a particle motion detector and where linked to the swim bladder, converts sound pressure into particle motion, which is detected by the inner ear. High sensitivity hearing species such as clupeids (twaite shad) have specialisations of the auditory apparatus where the swim bladder and inner ear are intimately connected and are able to detect frequencies to over 3kHz; with optimum sensitivity between 300Hz-1kHz (Nedwell et al. 2007). Atlantic salmon is not known to be sensitive to underwater noise changes, but as it possesses a swim bladder it is vulnerable to the rapid pressure change associated with a UXO detonation.

Marine cable installation, operation and decommissioning will generate underwater sound from a number of sources:

- Cable laying and rock placement (including presence of vessels);

- Geophysical survey; and
- UXO detonation (if required).

To calculate the zone of influence for recoverable and temporary injury to fish an assessment was conducted which combined literature review with underwater sound modelling. Sound propagation modelling, using a geometric spreading calculation, was used to determine the range at which the received sound attenuates to levels below defined thresholds for injury and disturbance. The assessment used thresholds for injury derived from Popper et al (2014). These reflect the current state of scientific knowledge.

The sound levels, injury thresholds, the calculations and the resulting zones of influence are described and provided in full in Appendix C of this NIS; and key information relevant to the assessment is summarised below.

Cable laying, rock placement and geophysical survey

Cable laying activities together with related activities including rock placement are continuous (non-pulse) activities expected to generate sounds up to 191dB re 1μPa @1m (0-peak). For non-pulse activities it is unlikely that death or tissue damage (barotrauma) will occur to fish. The typical behavioural response to sounds by fish might range from no change in behaviour, to a mild awareness (startle response) to larger movements of temporary displacement for the duration of the sound (Popper and Hastings 2009). Popper et al. (2014) identified that there is no direct evidence of permanent injury to fish species from shipping and other continuous noise (such as cable installation).

Most noise from a geophysical survey is generated at frequencies greater than 1kHz, above the auditory capacity of fish (generally between 0.2Hz to 1kHz). In addition, sound from survey equipment is targeted towards the seabed, meaning that effects to fish are only expected if they are within the immediate zone of ensonification below the survey vessel.

Of the Qualifying Interests, twaite shad is the only hearing specialist fish present within the Proposed Development. Nedwell et al. (2012) reviewed herring (also in the clupeid family) sensitivity to sources of noise from non-pulse cable laying operations (i.e. cable lay and trenching) and proposed effect ranges. Clupeids are expected to show strong avoidance behaviour (i.e. reaction by virtually all individuals) within 8m of the works, whilst significant avoidance (85% of individuals will react to noise) is expected within 66m.

Appendix C of this NIS concluded that for vessel noise, rock placement and cable trenching the zone of influence for fish recoverable injury is 17m, and the zone of influence for temporary injury is 110m. These results are slightly more conservative than the study by Nedwell et al (2012) but are generally consistent.

For geophysical survey the zone of influence for temporary injury is 2.2km. However, it should be noted that the spreading model assumes that sound is spread geometrically away from the source with an additional frequency-dependent absorption loss; it therefore provides conservative estimates. It does not take into consideration the conditions within the area, such as bathymetry, water depth or sediment type and thickness; all of which reduce the propagation of sound, and reduce the zone of influence.

During cable installation, the presence of several vessels and continued noise with 24-hour operations means it is likely that the most hearing specialist fish will demonstrate temporary avoidance behaviour from early on and remain outside the zone of influence (conservatively 110m radius) of operations for the duration of the installation activities.

For geophysical works the potential zone of influence is transient as it moves slowly in a constant direction along the principal survey line orientation. It is predicted that fish will avoid the area once operations have started and are extremely unlikely to move towards the sound source.

The works will not lead to any long term displacements as they are transient and temporary. Individuals are expected to return once the operation has passed through. However, it should be noted that the ability of small fish to take avoiding action may be limited, and temporary displacement may not therefore occur.

Temporary displacement of mobile species in the marine environment will not result in significant adverse effects for the individuals concerned unless it interferes with a critical lifecycle activity such as spawning. However, juvenile shad are known to forage in the nearshore environment, so some interaction may be possible.

Based on the above discussion, any disturbance effects from noise associated with operations will be localised, temporary and transient. There will be no effect on the distribution of the species. In addition, the Proposed Development will not affect the population structure, spawning extent or habitat or extent, or water quality. Considering the extent of inshore habitat available the likely effect on juvenile twaite is assessed as not significant.

UXO detonation (if required)

It is not expected that UXO detonation will be required within the Proposed Development. However, the Greenlink UXO desk-based assessment (1st Line Defence 2018) identified a high-risk area in the St Georges Channel; a former WWII sea mine ground. A UXO survey along the proposed centreline will be completed by the Installation contractor ahead of the installation campaign to identify any UXO along the route. A decision making process will be followed with an order of preference for any potential UXO encountered whereby the first preference is for the target to be avoided, if it cannot be avoided then it will be removed and if neither previous option is feasible, detonation is undertaken (Table 2-2). Therefore as a worst case the NIS assumes that one detonation may be required.

Appendix C of this NIS concluded that UXO detonation has the potential to cause fish mortality within 6.2km of the detonation site.

Underwater explosion produces a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs (i.e. swim bladders). Damage to visceral organs is most often the cause of fish mortality following exposure to underwater explosions. The most commonly injured organs are those with air spaces that are affected by the explosion's shock wave passing through the body of the fish, these include the body cavity, the pericardial sack and gut, however injuries of the swim bladder are most common. The swim bladders are subject to rapid contraction and overextension in response to explosive shock waveforms. Species which do not possess a swim bladder or have small swim bladders are likely to be more resistant to noise generated from explosions (Keevin and Hempen 1997).

Salmon and twaite shad will be sensitive to such disturbance. However, the explosion will be brief, with the shock waves attenuating rapidly in the water column, thus resulting in a restricted lethal zone (Continental Shelf Associates, Inc 2004). Although there is the potential that individuals will be killed the activity, if required, is unlikely to affect the viability of the species, populations or stocks.

Screening conclusion: No potential for significant effects / AA is not required

4.4.4 Bannow Bay SPA

4.4.4.1 Conservation objectives

To maintain the favourable conservation condition of light-bellied brent goose, shelduck, pintail, oystercatcher, golden plover, grey plover, lapwing, knot, dunlin, black-tailed godwit, bar-tailed godwit, curlew and redshank in Bannow Bay SPA, which is defined by the following list of attributes and targets:

- Population trend: Long term population trend stable or increasing.
- Distribution: There should be no significant decrease in the range, timing or intensity of use of areas by the species, other than that occurring from natural patterns of variation.

4.4.4.2 Assessment against conservation objectives

The most vulnerable birds to disturbance are birds located within the zone of influence (Table 4-1). Both visual and noise disturbance may result from the presence and movement of project vessels. Birds may take evasive action, but a single disturbance event will not have any immediate effect on the survival or productivity of an individual bird. Repeated disturbance, or disturbance over an extended period of time, can affect survival and productivity (Valente and Fischer 2011).

The extent to which a seabird responds to disturbance is dependent upon factors including period of breeding cycle during which disturbance occurs; duration, type and intensity of the disturbance; presence of opportunistic predators; and the degree of habituation with the disturbance (Showler et al. 2010). Some seabirds are more resilient to disturbance than others.

The Proposed Development lies 1.6km from the site. Large numbers of wintering wildfowl and waders feed on the mudflats and sandflats and use the fringing vegetation of reedbed and saltmarsh for roosting and feeding. The wildfowl and waders which the site supports are identified as sensitive to visual disturbance and lie within the zone of influence for disturbance identified for 'all other species' of 2km. Therefore, there is potential that over wintering birds from this site will be disturbed by installation activities.

The presence of installation vessels may cause noise and visual disturbance. This could cause birds within this SPA to cease feeding or move away from the area, which may affect the energy requirements of the birds and influence individual fitness. However, given that wintering birds in the SPA roost and feed on land and in the intertidal area they are unlikely to be observed along the Proposed Development. In addition, cable installation works are scheduled for the summer period reducing the likelihood of temporal overlap with the wintering birds. Any disturbance will be temporary, localised and will not significantly effect the availability of suitable habitat within the SPA and local area. Therefore visual disturbance is not expected to result in changes to the population trends and distribution of bird species within this SPA.

Screening conclusion: No potential for significant effects / AA is not required

4.4.5 Sites with cetacean or pinniped qualifying interests

Table 4-3 identified a 'possible' pressure-receptor pathway for the pressure underwater noise changes between the Proposed Development and nine Natura 2000 sites for which the qualifying interests are Annex II cetacean (bottlenose dolphin and harbour porpoise) and/or pinniped species.

As the pressure-receptor pathway is the same for all sites they have been grouped together for discussion below.

Marine cable installation, operation and decommissioning will generate underwater sound from a number of sources:

- Cable laying and rock placement (including presence of vessels);
- Geophysical survey; and
- UXO detonation (if required).

Both cetaceans and pinnipeds have evolved to use sound as an important aid in navigation, communication and hunting (Richardson et al. 1995). It is generally accepted that exposure to anthropogenic sound can induce a range of behaviour effects to permanent injury in marine mammals. Loud and prolonged sound above background levels is considered to be noise and may have an effect on marine life.

This may mask communicative or hunting vocalisations, preventing social interactions and effective hunting.

High intensity noises such as from seismic survey, explosions and pile driving can cause temporary or permanent changes to animals' hearing if the animal is exposed to the sound in close proximity and, in some circumstances, can lead to the death of the animal (Richardson et al. 1995). Where the threshold of hearing is temporarily damaged, it is considered a temporary threshold shift (TTS), and the animal is expected to recover. If there is permanent damage (permanent threshold shift (PTS)) where the animal does not recover, social isolation and a restricted ability to locate food may occur, potentially leading to the death of the animal (Southall et al. 2007).

Behavioural disturbance from underwater sound sources is more difficult to assess than injury and is dependent upon many factors related to the circumstances of the exposure (Southall et al. 2007, NFMS 2018). An animal's ability to detect sounds produced by anthropogenic activities depends on its hearing sensitivity and the magnitude of the noise compared to the amount of natural ambient and background anthropogenic sound. In simple terms for a sound to be detected it must be louder than background and above the animal's hearing sensitivity at the relevant sound frequency.

Behavioural responses caused by disturbance may include animals changing or masking their communication signals, which may affect foraging and reproductive opportunities or restrict foraging, migratory or breeding behaviours; and factors that significantly affect the local distribution or abundance of the species. An animal may swim away from the zone of disturbance and remain at a distance until the activities have passed. Behavioural disturbance to a marine mammal is hereafter considered as the disruption of behavioural patterns, for example: migration, breeding and nursing.

To calculate the zone of influence for both levels of effect (injury and disturbance), an assessment was conducted which combined literature review with underwater sound modelling. Sound propagation modelling, using a geometric spreading calculation, was used to determine the range at which the received sound attenuates to levels below defined thresholds for injury and disturbance. The assessment used both the recently published American National Marine Fisheries Service (NMFS) (2018) thresholds for the onset of PTS and TTS and the thresholds defined by Southall *et al.* (2007). These reflect the current peer-reviewed published state of scientific knowledge.

The sound levels, injury and disturbance thresholds, the calculations and the resulting zones of influence are described and provided in full in Appendix C of this NIS; and key information relevant to the assessment is summarised below.

Injury from continuous sound - cable installation

There is little information on potential effects of sound on marine mammals, resulting from the installation and operation of subsea cables; research has typically focused on high intensity impulsive sound sources such as seismic survey and piling. The Oslo and Paris (OSPAR) Convention (2012) considered that sound associated with the installation, removal or operation of submarine cables is less harmful compared to impulsive sound activities such as seismic surveys, military activities or construction work involving pile driving (OSPAR Convention 2012). However, frequent noise exposure can lead to longer term effects associated with continuous stress (National Research Council 2003). Chronic stress in marine mammals can result in infectious, neoplastic, allergic, inflammatory and autoimmune diseases, and also can reduce reproduction; however, stress-induced reactions are hard to identify (National Research Council 2003).

The Greenlink Marine EIAR - Technical Appendix C (provided as Appendix C of this NIS) concluded that sound resulting from cable installation activities (DP vessel, trenching, rock placement etc.) does not exceed the thresholds for permanent (permanent threshold shift, PTS) or temporary (temporary threshold shift, TTS) injury. Cetaceans and pinnipeds are therefore not at risk of injury from the cable installation (rock placement and vessel noise).

Injury from continuous sound – geophysical survey

The Greenlink Marine EIAR - Technical Appendix C (provided as Appendix C of this NIS) concluded that:

- Bottlenose dolphin (mid-frequency cetaceans), are vulnerable to permanent injury within 2.6m and to temporary injury within 7m of the multi-beam echosounder.
- Harbour porpoise (high-frequency cetacean) are vulnerable to sound generated by the multi-beam echosounder, sidescan sonar and sub-bottom profilers with the largest zone of influence being from the multibeam echosounder. Permanent injury could occur within 110m and temporary injury within 180m of the multi-beam echosounder.
- Pinnipeds in water are vulnerable to sound from the multi-beam echosounder and sidescan sonar, with permanent injury potentially occurring within 15m and temporary injury within 40m of the multi-beam echosounder.

The geophysical survey contractor will follow - DAHG (2014) 'Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' Adherence to the guidelines constitutes best practice and will, in most cases, reduce the risk of deliverable to injury to marine mammals to negligible levels. Adherence to the guidelines has been incorporated into the Proposed Development (Table 2-2).

Injury from impulsive sound

It is unknown how many, if any, UXO detonations will be required within the Proposed Development. The chances of UXO detonation is very low, however, to be conservative it is assumed that one detonation may be required.

Should UXO be found which requires clearance by detonation it is assumed that there will be a relatively large release of impulsive sound energy, creating high amplitude shock waves (von Benda-Beckmann et al. 2015). Peak source levels will depend on the quantity and nature of explosive material. At close range there will be risk a of mortality as relatively small quantities of explosive can result in significant SPLs, e.g. Richardson et al. (1995) reported that 0.5kg of TNT was associated with a peak of 267dB re 1μPa @ 1m.

The precise injury effect range cannot be stated in advance of information on the nature and quantity of explosive material potentially involved, which will not be known until a UXO is identified. To provide a worst-case, the Greenlink Marine EIAR - Technical Appendix C (provided as Appendix C of this NIS) modelled the sound from a 794kg explosive (equivalent to a sea mine), which 1st Line Defence (2018) identified as the largest explosive device to have been used historically in the region. It should be noted that this size of magnetic anomaly has not been identified along the Proposed Development.

Results from the assessment are highly conservative, due to the high explosive weight used to estimate the sound levels. In addition, the geometric spreading modeling does not take into consideration variables such as water depth, source and receiver depths, temperature gradients, salinity, seabed ground conditions bathymetry, water depth or sediment type and thickness, all of which affect received levels.

The modelling results conclude that cetaceans and pinnipeds are at risk of temporary and permanent injury from UXO detonation. At close range there will be risk of mortality as relatively small quantities of explosive can result in significant sound pressure levels.

- Bottlenose dolphin (mid-frequency cetaceans), are vulnerable to permanent injury within 5.8km and to temporary injury within 8.6km of the UXO detonation;
- Harbour porpoise (high-frequency cetacean) are vulnerable to permanent injury within 23km and to temporary injury within 27km of the UXO detonation; and
- Pinnipeds in water are vulnerable to permanent injury with 13km and to temporary injury within 17km from the UXO detonation.

Von Benda-Beckmann *et al.* (2015) studied the effect of UXO detonations on harbour porpoise in the North Sea. The study showed that a detonation of 263kg of explosive (794kg explosive weight has been used for this assessment) could result in physical injury within 500m of the explosion.

Disturbance from continuous sound - cable installation

The modelling presented in the Greenlink Marine EIAR - Technical Appendix C (provided as Appendix C of this NIS) concluded that all marine mammals are vulnerable to disturbance from cable installation activities, but the zone of influence is small; 130m radial distance from activities. The cable installation activities will move slowly along the cable route and although animals may briefly avoid the activity they will return to an area once the activity has passed through. The current level of shipping and ambient sound within the Celtic Sea will not increase significantly from the presence of the project vessels during the cable installation.

Disturbance from continuous sound – geophysical survey

The modelling presented in the Greenlink Marine EIAR - Technical Appendix C (provided as Appendix C of this NIS) concluded that disturbance could occur within up to 2.6km.

Evidence of the effects of geophysical surveys on cetaceans is limited but BEIS (2018) summarises the results of a study carried out in the Moray Firth. It observed responses to a 10-day 2D seismic survey which exposed a 200km^2 area to noise throughout that period. The survey reported a relative decrease in density of harbour porpoise within 10km of the survey vessel, but effects were brief with animals returning to the area within 19 hours of cessation of activities.

The underwater sound changes associated with the cable installation and the geophysical survey, and therefore the associated potential for disturbance is generally acknowledged to be lower when compared to an activity such as use of air guns during 2D and 3D seismic and wind farm piling. Animals will have sufficient time to avoid the installation and survey vessels, and it is unlikely that they will swim over operating equipment.

The proposed activities will be restricted in duration and will progress slowly within the Proposed Development. Animals may actively avoid the activity, but will return to the area once the vessels have passed through. The Proposed Development will therefore not act as a barrier to movement between sites, or cause significant short or long-term disturbance.

Disturbance from UXO detonation

An UXO detonation is likely to result in disturbance to marine mammals over a large area, regardless of the weight of the explosive. The case specific disturbance range cannot be stated in advance of information on the nature and quantity of explosive material potentially involved; this assessment therefore presents a worst-case. Disturbance resulting from a single 794kg UXO detonation would cover an area of up to 9,160km^2.

4.4.5.1 Saltee Islands SAC

Conservation objectives – Grey Seal

To maintain the favourable conservation condition of Grey Seal in Saltee Islands SAC, which is defined by the following lists of attributes and targets:

a. Access to suitable habitat – species range within the site should not be restricted by artificial barriers to site use.
b. Breeding behaviour – The breeding sites should be maintained in a natural condition.

c. Moulting behaviour - The moult haul-out sites should be maintained in a natural condition.
d. Resting behaviour - The resting haul-out sites should be maintained in a natural condition.
e. Population composition - The grey seal population occurring within this site should contain adult, juvenile and pup cohorts annually

Assessment against conservation objectives

The Saltee Island SAC lies 6.1km from the Proposed Development and therefore it is possible that grey seal from the site will be present in the water, especially during the summer months of cable installation e.g. May to August. From August through to December animals are likely to be hauled up on beaches for pupping. At closest range the beaches are located 6.2km from the Proposed Development.

Seal are likely to flee if vessels approach within 900m (Brasseur & Reijnders,1994); suggesting that during cable installation and the geophysical survey they will avoid the area before they encounter sound levels that will harm them. In addition, given the distance of Saltee Island (6.1km) from the Proposed Development, breeding, resting and moulting behaviour will not be effected.

Cable installation and geophysical survey will be transient and sound levels generated will not act as an artificial barrier. Therefore, the Proposed Development will not restrict access to suitable grey seal habitat at the site and the surrounding area.

Screening Conclusion for continuous sound: No potential for significant effects / AA is not required

As discussed above, pinnipeds are vulnerable to permanent injury within 17km from the UXO detonation. However, the thresholds used for injury are for pinnipeds in water. Therefore, UXO detonation will not affect breeding, moulting and resting behaviour of grey seal in the site.

UXO detonation, if required, is a brief one-off event (less than one day) therefore it will not act as an artificial barrier to seals moving on and off the site.

If a number of adults and juveniles from the SAC are within the water and the zone of influence at the time of UXO detonation, they could be killed or injured. Following detonation, the population of seals in the site will still contain adults and juveniles. However, the ratio of adults and juveniles within the site could be disrupted thus effecting population composition.

Screening Conclusion for UXO detonation: Likely Significant Effects cannot be ruled out / AA is required

4.4.5.2 Slaney River Valley SAC

Conservation objectives – Harbour Seal

To maintain the favourable conservation condition of Harbour Seal in the Slaney River Valley SAC, which is defined by the following list of attributes and targets:

- Access to suitable habitat: Species range within the site should not be restricted by artificial barriers to site use.
- Breeding behaviour: The breeding sites should be maintained in a natural condition.
- Moulting behaviour: The moult haul-out sites should be maintained in a natural condition.
- Resting behaviour: The resting haul-out sites should be maintained in a natural condition.
- Disturbance: Human activities should occur at levels that do not adversely affect the harbour seal population at the site.

Assessment against conservation objectives

Slaney River Valley SAC lies 29.7km from the Proposed Development. The site supports regionally significant numbers of harbour seal. Animals occur year-round in Wexford Harbour where several sandbanks are used for breeding, moulting and resting activity. At least 27 harbour seal regularly occur within the site. Harbour seal come ashore during June to give birth and mate again around this time. Harbour seals also come to shore to moult during July and August often forming large groups on sheltered shores that have ready access to the sea.

Seal are likely to flee if vessels approach within 900m (Brasseur & Reijnders,1994); suggesting that during cable installation and geophysical survey they will avoid the area before they encounter sound levels that will harm them. In addition, given the distance of Slaney River Valley SAC (29.7km) from the Proposed Development, breeding, resting and moulting behaviour will not be effected.

Cable installation and geophysical survey will be transient and sound levels generated will not act as an artificial barrier. Therefore, the Proposed Development will not restrict access to suitable grey seal habitat at the site and the surrounding area.

Screening Conclusion for continuous sound: No potential for significant effects / AA is not required

UXO detonation, if required, is a brief one-off event (less than one day). Therefore, UXO detonation will not act as artificial barrier to seals moving on and off the site.

As discussed above, pinniped are vulnerable to permanent injury within 17km from the UXO detonation. However, the thresholds used for disturbance are for pinnipeds in water. Therefore, UXO detonation will not affect breeding, moulting and resting behaviour of harbour seal in the site.

If a number of harbour seal from SAC are in the within the water and the zone of influence at the time of UXO detonation, they could be killed or injured. This could adversely effect the population of harbour seal at the site. The screening has returned a conclusion of uncertain effects because it is not known if sufficient numbers would be present within the Proposed Development to cause a significant effect. Therefore, following the pre-cautionary principle AA is required.

Screening Conclusion for UXO detonation: Likely Significant Effects cannot be ruled out / AA is required

4.4.5.3 Pembrokeshire Marine/ Sir Benfro Forol SAC

Conservation objectives

Grey seal populations should not be reduced as a consequence of human activity. The species population within the site (grey seal) is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future:

- Their range within the SAC and adjacent inter-connected areas is not constrained or hindered.
- There are appropriate and sufficient food resources within the SAC and beyond.
- The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing."

Assessment against conservation objectives

Pembrokeshire Marine/ Sir Benfro Forol SAC lies 24.3km from the Irish Offshore component of Greenlink and therefore it is possible that grey seal from the site will be present in the water, especially during the summer months of cable installation e.g. May to August. From August through to December animals are likely to be hauled up on beaches for pupping.

Seals are likely to flee if vessels approach within 900m (Brasseur & Reijnders,1994); suggesting that during cable installation and geophysical survey, they will avoid the area before they encounter sound levels that will harm them. In addition, given the distance of Pembrokeshire Marine/ Sir Benfro Forol SAC (24.3km) from the Irish Offshore activities, breeding, resting and moulting behaviour will not be effected.

Given the distance to the site it is unlikely that sufficient numbers of animals will be present within the zone of influence for UXO detonation to significantly affect the population. A UXO detonation will not affect the grey seal habitat and food resource. In addition, if required, UXO detonation, will be a brief one-off event (less than one day) which will not affect the range of grey seal from the site.

The Wales Marine component of Greenlink crosses the site, and therefore the effects of the project have also been considered by the Greenlink Marine – Habitats Regulation Assessment (HRA) Wales. As Greenlink is a linear project, the activities in the marine environment will occur as one set of activities i.e. the cable installation spread will move along the cable route passing through the Proposed Development and the Irish Offshore through to Marine Wales or vice versa. Animals disturbed will be able to move in and around the works returning to areas quickly after the activity has passed through. Therefore there will be no intra-project cumulative effects.

Screening Conclusion: No potential for significant effects / AA is not required

4.4.5.4 Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC, West Wales Marine/ Gorllewin Cymru Forol SAC, North Anglesey Marine/ Gogledd Môn Forol SAC and North Channel SAC

Conservation objectives

The conservation objectives for the four sites in UK waters are the same:

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise.

To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:

1. The species is a viable component of the site.
2. There is no significant disturbance of the species.
3. The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

Assessment against conservation objectives

It is possible that harbour porpoise from these sites may be observed in the area given that the Proposed Development is located in the same management unit as these sites (Celtic and Irish Sea MU).

The zone of influence of disturbance from cable installation and the geophysical survey is small (2.6km). These sites are located between 35km and 260km from the Proposed Development. Therefore, noise generated from cable installation and geophysical survey will not result in significant disturbance to harbour porpoise from these sites. In addition, noise generated from cable installation and survey operations will not affect harbour porpoise habitat or prey items and harbour porpoise will still be a viable component of these sites.

If UXO detonation was required within the Proposed Development or Irish Offshore there is the potential that the zone of influence for disturbance (52km radial distance) would overlap with the closest of the sites (West Wales Marine/ Gorllewin Cymru Forol SAC). However, the disturbance will be a brief one-off event (less than a day), potentially only overlapping with a small portion of the site. Therefore, harbour porpoise will still remain a viable component of these sites following detonation. In addition, the detonation would not significantly effect harbour porpoise habitat or prey items.

The Wales Marine component of Greenlink crosses the site West Wales Marine/ Gorllewin Cymru Forol SAC, and therefore the effects of the project have also been considered by the Greenlink Marine – Habitats Regulations Assessment (HRA) Wales. As Greenlink is a linear project, the activities in the marine environment will occur as one set of activities i.e. the cable installation spread will move along the cable route passing through the Proposed Development and the Irish Offshore through to Marine Wales or vice versa. Animals disturbed will be able to move in and around the works returning to areas quickly after the activity has passed through. Therefore there will be no intra-project cumulative effects.

Screening Conclusion: No potential for significant effects / AA is not required

4.4.5.5 Cardigan Bay/ Bae Ceredigion SAC and The Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau SAC

Conservation objectives – bottlenose dolphin

The conservation objectives from these two sites are the same.

- Populations: The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include:
    - population size
    - structure, production
    - condition of the species within the site
- Range: The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.
- Supporting habitat: The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include;
    - distribution
    - extent
    - structure
    - function and quality of habitat
    - prey availability and quality.
- Restoration and recovery: bottlenose dolphin populations should be increasing.

Assessment against conservation objectives

It is possible that bottlenose dolphin from these sites are observed in the area given that the Proposed Development is located in the same management unit (i.e. the Offshore Channel and SW England MU). However, the baseline description concluded the densities of animals in the region are low.

The zone of influence of disturbance from cable installation and geophysical survey is small (2.6km). The sites are located 120km and 96.3km from the Proposed Development. Therefore, noise generated from cable installation and geophysical survey will not result in significant disturbance to bottlenose dolphin from these sites. In addition, noise generated by the Proposed Development will not affect bottlenose dolphin habitat or prey items and bottlenose dolphin will still be a viable component of these sites.

If UXO detonation was required within the Proposed Development or Irish Offshore, the sites lie outside the zone of influence for disturbance. It is therefore unlikely that the brief disturbance caused by a detonation will alter bottlenose dolphin behaviour, affect their range, alter their habitat or cause a reduction in available prey items.

The Wales Marine component of Greenlink are slightly closer to the sites and therefore the effects of the project have also been considered by the Greenlink Marine – Habitats Regulation Assessment (HRA) Wales. As Greenlink is a linear project, the activities in the marine environment will occur as one set of activities i.e. the cable installation spread will move along the cable route passing through the Proposed Development and the Irish Offshore through to Marine Wales or vice versa. Animals disturbed will be able to move in and around the works returning to areas quickly after the activity has passed through. Therefore there will be no intra-project cumulative effects.

Screening Conclusion: No potential for significant effects / AA is not required

4.5 *Cumulative effects*

The Habitats Directive requires that plans or projects are assessed alone and in-combination with other plans or projects to determine whether a likely significant effect to Natura 2000 sites could occur. Only plans or projects that would increase the likelihood of significant effects should be considered.

The nature of a linear interconnector cable project mean that the majority of potential pressures result in temporary or short-term and localised effects. With the exception of UXO detonation, all effects, as a result of the Proposed Development, will be restricted to a zone within 4km either side of the Proposed Development (Table 4-1). An initial area of search of 10km has therefore been applied either side of the Proposed Development to identify plans and projects for inclusion within this assessment.

Known types of projects, plans and licensed activities considered include:

- Renewable energy projects i.e. offshore wind farms;

- Sites for marine aggregate dredging and disposal;
- Cables and pipelines;
- Oil and gas exploration and development;
- Carbon Capture and Storage; and
- Military Practice Areas.

Projects, plans and licensed activities have been identified through search of the Department of Housing, Planning and Local Government (DHPLG) websites, consultation with the Foreshore Unit, and a desk-top review of published literature and websites.

No commercial fishing, shipping or recreational plans have been identified in the area. Current commercial fisheries, shipping interests and recreational use has been scoped out of the list of projects as they are considered to represent baseline conditions, and are not considered as projects, plans or licensed activities.

Table 4-5 presents known projects, plans and licences situated within 10km of the Proposed Development. Figure 4-1 (Drawing P1975-CUMU-002) presents the projects in relation to the Proposed Development. No known military practise areas, marine renewable sites, or marine aggregate dredging sites are currently located within the vicinity of the Proposed Development.

Table 4-5 Projects within 10km of the Proposed Development

Project Category	Name / Type of Project	Status	Operator/Owner/ Other Details	Closest Distance to the Project (km)
Disposal site	Kilmore Quay Disposal Site	Application	Wexford County Council	3
Cables	Celtic (Telecom)	Disused	BT	0
	Solas (Telecom)*	Active	Vodafone	0.8
	Pan European Crossing 1 (Telecom)* **	Active	LEVEL 3	1.3
	ESAT 1 (Telecom)*	Active	BT	2.7
	Eir (Fibre Optic)	Application/Consultation	Eir	8
Oil and gas	Wellhead 50/3-3	Abandoned		2.8
	Wellhead 50/3-1	Abandoned		7.5
	Wellhead 50/3-2	Abandoned		7.7
	Wellhead 50/2-1	Abandoned		8.9
Aquaculture	Seaweed harvesting	Consultation	K & M Aquatic Plant Enterprises Ltd t/a Ocean Leaves	3

Project Category	Name / Type of Project	Status	Operator/Owner/ Other Details	Closest Distance to the Project (km)
	Oyster beds	Active	Woodstown Bay Shellfish Ltd (plus other companies)	9
Scientific survey	ADCP deployment	Consultation	TechWorks Marine Ltd	7
Offshore wind	Celtic Sea Array	Application / Consultation	SSE Renewables (Ireland) Ltd	0

* The cables intersect the Proposed Development outside of the Proposed Development in the Irish Offshore area, therefore the distance to the cable from the Proposed Development is provided here. It is worth noting that Solas crosses within the 10km buffer, however this is a discrete location and the two cables running parallel for 20 km was deemed more significant.

** Previously known as UK-Ireland Crossing 1

For there to be a potential cumulative effect (PCE) between the Proposed Development and another project, plan or licensed activity there must be a common pressure-receptor pathway which overlaps spatially and temporally. A screening exercise was undertaken, presented below, to determine if any of the projects, plans and activities identified have:

a. A common-pressure receptor pathway with the Proposed Development (Section 4.5.1.2);

b. Activities, the effects of which overlap spatially with the Proposed Development (Section 4.5.1.3); and

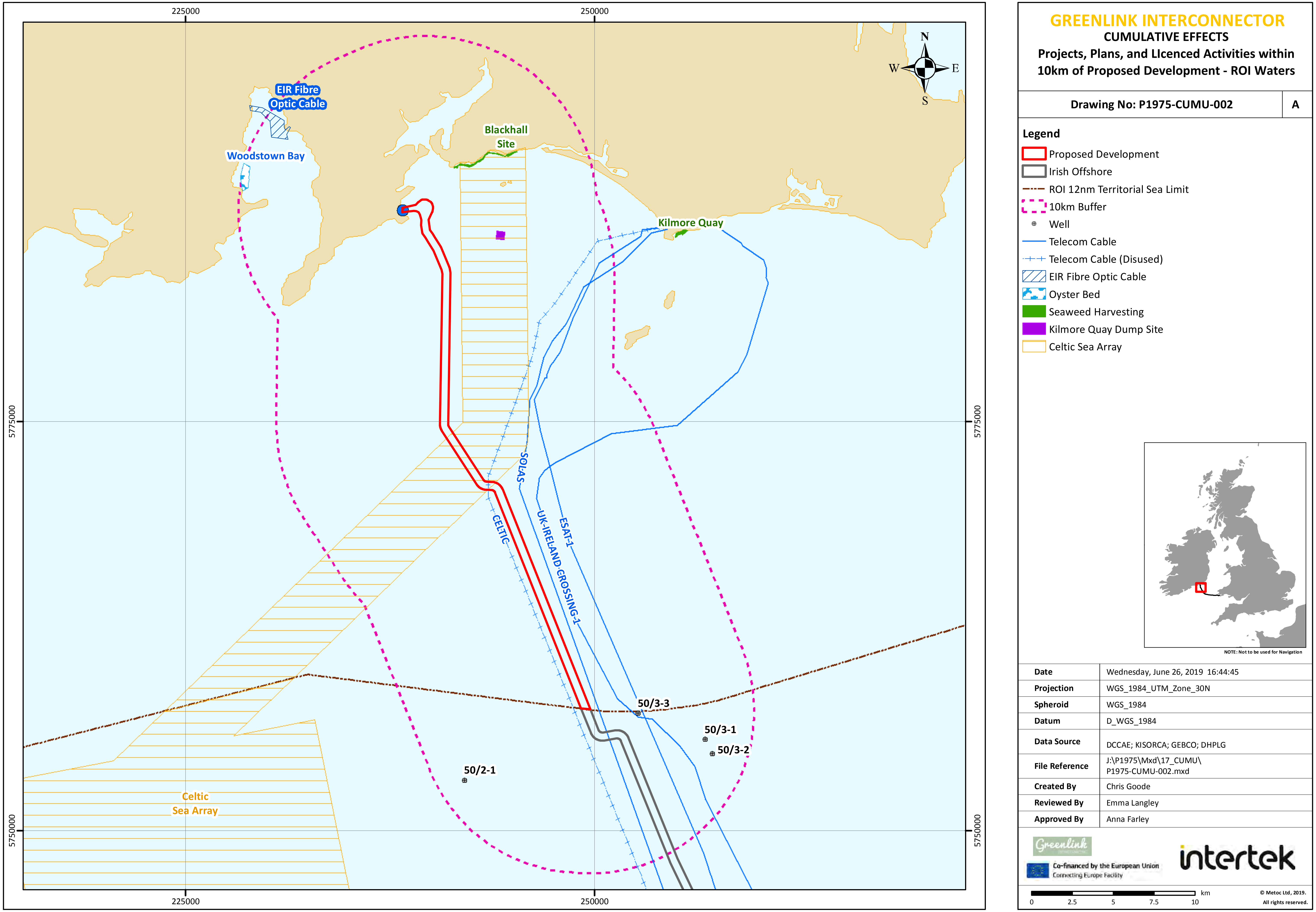
c. Activities, the effects of which overlap temporally with the Proposed Development (Section 4.5.1.4).

GREENLINK INTERCONNECTOR

CUMULATIVE EFFECTS

Projects, Plans, and LIcenced Activities within 10km of Proposed Development - ROI Waters

Drawing No: P1975-CUMU-002 | **A**



Date	Wednesday, June 26, 2019 16:44:45
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; KISORCA; GEBCO; DHPLG
File Reference	J:\P1975\Mxd\17_CUMU\ P1975-CUMU-002.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union Connecting Europe Facility

0 2.5 5 7.5 10 km

4.5.1.2 Common pressure-receptor pathway assessment

Of the projects listed in Table 4-5, the Celtic telecommunications cable and four abandoned well heads have been screened out from further consideration. The wellheads are decommissioned and no further activities that could affect the environment will be associated with them. GIL is seeking permission to cut the Celtic telecommunication cable and therefore no further activity will be associated with this structure.

The remaining projects fall into four categories: disposal sites; cables; aquaculture; and offshore wind. An activity / pressure/ receptor matrix for these four categories has been developed (Table 4-6) to define the common pressures associated with the project types, and which receptors can be effected. If there is no common pressure-receptor pathway the project is screened out.

Table 4-6 Activity / pressure / receptor matrix for identified projects

Category	Phase	Pressure	Receptors			
			Habitats	Fish	Birds	Marine Mammals
Disposal site	Operation	Siltation rate changes				
		Disturbance				
		Underwater noise changes				
		Physical change (to another seabed type)				
Cables	Installation and Repair	Penetration and/or disturbance including abrasion				
		Siltation rate changes				
		Hydrological changes (inshore/ local)				
		Physical change (to another seabed type)				
		Disturbance				
		Underwater noise changes				
Aquaculture	Operation	Disturbance				
		Penetration and/or disturbance including abrasion				
Offshore wind	Survey	Penetration and/or disturbance including abrasion				
		Disturbance				
		Underwater noise changes				

4.5.1.3 Spatial overlap assessment

For there to be a potential cumulative effect (PCE) the effects from the Proposed Development and other plans and projects must overlap spatially. If there is no spatial overlap between the pressures, the pressure from the plan or project can be screened out at this stage. Table 4-7 presents an assessment of the projects to determine if spatial overlaps exist with the Proposed Development.

Table 4-7 Spatial overlap assessment

Key	Screened out - No common pressure-receptor pathway	Screened out - Common pressure receptor pathway but outside Proposed Development zone of influence	Screened in - Common pressure receptor pathway and within Proposed Development zone of influence

Project	Distance*	Greenlink pressures and zone of influence (km)					
		Penetration and/or disturbance including abrasion	Siltation rate changes	Hydrological changes (inshore/ local)	Physical change (to another seabed type)	Disturbance	Underwater noise changes
		0.02	0.10	0.00	0.01	4.00	2.60
Kilmore Quay Disposal Site	3km						
Solas (Telecom)	0.8km						
Pan European Crossing 1 (Telecom)	1.3km						
ESAT 1 (Telecom)	2.7km						
Hibernia Seg D (Telecom)	0.8km						
Eir (Fibre Optic)	8km						
Seaweed harvesting	3km						
Oyster beds	9km						
Celtic Sea Array	0km						

4.5.1.4 Temporal overlap assessment

Although Table 4-7 has determined that there is a spatial overlap between six projects and the Proposed Development, the effects must overlap temporally as well as spatially for there to be a PCE.

The four telecommunication cables are in-service. The pressure-receptor pathways identified above relate to potential effects should repair works need to be carried out on the cables. As it cannot be identified with any confidence when this could take place the projects have to be screened out of the assessment.

The Kilmore Quay Disposal site application has a timeline that completes in 2020. Works will be completed prior to the start of the marine activity in the Proposed

Development. However, as it has not been consented there is the potential the project could be delayed and could eventually overlap temporally with Greenlink.

The Celtic Sea Array project is an application to undertake geophysical, geotechnical and environmental survey within five years of licence determination. The survey area for a potential cable export route crosses the Greenlink Proposed Development. There is therefore the potential that the Celtic Sea Array survey works will spatially and temporally overlap with the installation of the Proposed Development in a manner that will cause a PCE.

4.5.1.5 PCE Assessment

There are three common pressure-receptor pathways between the Proposed Development and either Kilmore Quay disposal site and/or Celtic Sea Array survey. This are discussed below:

Penetration and/or disturbance including abrasion
There is no spatial overlap between the Kilmore Quay disposal site and the Proposed Development for this pressure as the site is 3km distance. The area of spatial lap between Celtic Sea Array and the Proposed Development is outside of a Natura 2000 site and therefore there is no potential for a cumulative effect on Qualifying Interest habitats within Natura 2000 sites from this pressure.

Disturbance
There is potential that vessels for the Proposed Development and those for the Celtic Sea Array and Kilmore Quay disposal site could be in the same area for a short period of time (temporal and spatial overlap). However, all projects are transient, temporary and localised with vessels that are slow moving and disturbance is unlikely to be felt beyond existing disturbance sources in the area.

One of the proposed export cable corridors to be surveyed for the Celtic Sea Array project passes close to the Keeragh Islands SPA. There is the potential that if works along the Proposed Development and Celtic Sea Array occur near to the Keeragh Islands SPA at the same time there may be a temporary elevation in visual disturbance to breeding cormorant in the Keeragh Islands SPA. Cormorants breeding season ranges from February to September, so there is potential for the Celtic Sea Array works and the Proposed Development activities to occur during this time. The sensitivity of the receptor has been assessed as medium due to their high susceptibility for disturbance. However, the Proposed Development is located 4.5km from the breeding colonies and therefore outside the zone of influence for disturbance (2km), therefore the magnitude of this effect has been assessed as low. The significance of the potential cumulative effect is assessed as Not Significant.

Underwater noise changes
It is possible that noise generated from the Celtic Sea Array geophysical survey will occur at the same time as the Proposed Development, however given the uncertainties around scheduling on both projects it is difficult to confirm if there will be a temporal overlap.

Fish and marine mammals are the receptors potentially affected by this pressure. The underwater noise modelling (Appendix C) concluded that there is no significant injury level effects on marine mammals or fish from continuous noise sources (vessels and geophysical surveys). Although screening has concluded that disturbance level effects on Qualifying Interests of Natura 2000 sites from geophysical survey are not significant, when considered alongside other activities occurring within the same region it may give rise to a significant PCE.

There is the potential for a temporal overlap with two surveys occurring concurrently or two surveys occurring consecutively. However, data acquisition can be impaired if two geophysical surveys occur at the same time in close proximity due to equipment interference. It is therefore more likely that the surveys would occur consecutively. This would result in an extension of the time period that fish and marine mammals would be disturbed.

Fish

For both projects the zone of influence will move as activity progresses along the cable route or along the survey corridor. Fish will avoid the noisy activity once operations have started and are extremely unlikely to move towards the sound source. However they will return to the area once the activities have passed through. Therefore, it is unlikely that fish will experience a significant effect other than temporary displacement from the immediate area surrounding the activities. Neither project will block migration pathways to and from rivers and therefore will not adversely affect the conservation objectives of the Natura 2000 sites in the area designated to conserve Annex I fish i.e. River Barrow and River Nore SAC, Lower Suir River SAC and Slaney River Valley SAC. It is concluded that if a cumulative effect occurs it will be Not Significant.

Marine mammals

With respect to marine mammals, any disturbance and subsequent displacement of animals from an area surrounding a development has the potential to affect communication, feeding and foraging opportunities and may restrict migration routes. An animal may swim away from the zone of discomfort and be excluded until the activities have passed. Marine mammals are wide ranging across the Celtic Sea but their range could be restricted if a number of similar noisy activities in a region reduced the suitable available habitat.

The Proposed Development and Celtic Sea Array do not cross any Natura 2000 sites designated for the conservation of marine mammals, but both are in close proximity to the Saltee Islands SAC designated to conserve grey seal. Celtic Sea Array is 1km to the west at the closest point of approach, whilst the Proposed Development is 6.1km to the west.

For both projects the zone of influence will move as activity progresses along the cable route or along the survey corridor. Grey seal will avoid the noisy activity once operations have started and are extremely unlikely to move towards the sound source. However they will return to the area once the activities have passed through. Therefore, it is unlikely that marine mammals will experience a significant effect other than temporary displacement from the immediate area surrounding the activities. The magnitude of the potential cumulative effect has been assessed as low given the effects are temporary, localised and reversible. The sensitivity of the receptor has been assessed as medium reflecting the sensitivity of species to underwater noise changes. The significance of the potential cumulative effect has been assessed as Not Significant.

4.5.1.6 Conclusion

Of the 14 projects, plans or activities identified within 10km of the Proposed Development screening for potential cumulative effects concluded that 12 projects could be screened out on the grounds that there was either no common pressure-receptor pathway or that the pressure-receptor pathways do not overlap spatially.

For one project, Kilmore Quay Disposal site, the common pressure-receptor pathways do have the potential to overlap spatially. However, the licensed activities will be completed prior to the start of the Proposed Development. Therefore there is no potential for cumulative effects.

It has been identified that there is the potential that the Celtic Sea Array survey could overlap spatially and temporally with the Proposed Development. Table 4-8 presents the conclusions of the assessment.

Table 4-8 Celtic Sea Array - PCE conclusion

Receptor	Qualifying Interest	Natura 2000 site(s)	PCE?
Habitats	None – no spatial overlap		No PCE
Fish	Twaite shad	River Barrow and River Nore SAC Lower Suir River SAC Slaney River Valley SAC	PCE – Not Significant
Birds	Cormorant	Keeragh Islands SPA	PCE – Not Significant
Marine mammals	Grey seal	Saltee Islands SAC	PCE – Not Significant

4.6 Screening Statement and Conclusions

To determine whether the Proposed Development and Campile Estuary is likely to have a significant effect on any Natura 2000 sites, either individually or in-combination with other plans or projects, AA screening was carried out.

The screening assessed 16 Natura 2000 sites that were either within the direct zone of influence of the Proposed Development or contain mobile Annex II species which could potentially travel into the Proposed Development.

A review of the Proposed Development identified seven pressures that could be exerted on Qualifying Interests during installation, maintenance, repair, operation and decommissioning. These were:

- Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion

- Siltation rate changes, including smothering (depth of vertical sediment overburden)
- Hydrological changes (inshore/local)
- Physical change (to another seabed type)
- Disturbance
- Underwater noise changes
- Electromagnetic changes

Sites were assessed to determine if there was a potential pressure-receptor pathway between the Proposed Development and the Qualifying Interest(s).

Initial screening concluded, that it is considered possible that there exists a pressure-receptor pathway between the Proposed Development and the Qualifying Interests of 13 of the 16 sites reviewed (Table 4-3). Further analysis of the likely significant effects taking into consideration the sites conservation objectives identified three sites, where it cannot be ruled out that the Proposed Development will not have a likely significant effect. Table 4-5 summarises the conclusions of the assessment of likely significant effects.

Fourteen other projects or plans within 10km of the Proposed Development were also assessed to determine if there was a potential for cumulative effects on the Natura 2000 site. The potential for cumulative effects with the Celtic Sea Array survey was identified but the assessment concluded that the significance of the PCE in each case will be not significant.

Screening has concluded that Appropriate Assessment is required for:

- Hook Head SAC (site code: IE0000764)
- Saltee Islands SAC (site code: IE0000707)
- Slaney River Valley SAC (side code: IE0000781)

Table 4-9 Summary - Potential for likely significant effects

Site Name & Code	Applicable Qualifying Interest	Potential pressure on site	Conclusion
Hook Head SAC - IE0000764	Large shallow inlets and bays Reefs	Penetration and / or disturbance including abrasion Physical change (to another seabed type)	LSE cannot be ruled out / AA is required
River Barrow and River Nore SAC - IE0002162	Otter	Disturbance	No potential for significant effects / AA is not required
	Twaite shad, Atlantic salmon (only in fresh water)	Underwater noise changes	No potential for significant effects / AA is not required

Site Name & Code	Applicable Qualifying Interest	Potential pressure on site	Conclusion
Lower River Suir SAC - IE0002137	Twaite shad, Atlantic salmon (only in fresh water)	Underwater noise changes	No potential for significant effects / AA is not required
Slaney River Valley SAC - IE0000781	Twaite shad, Atlantic salmon (only in fresh water)	Underwater noise changes	No potential for significant effects / AA is not required
	Harbour seal	Underwater noise changes - UXO detonation	LSE cannot be ruled out / AA is required
Bannow Bay SPA - IE0004033	Wintering birds: Light-bellied Brent goose, Shelduck, Pintail, Oystercatcher, Golden plover, Grey plover, Lapwing, Knot, Dunlin, Black-tailed godwit, Bar-tailed godwit, Curlew, Redshank	Visual disturbance	No potential for significant effects / AA is not required
Saltee Islands SAC - IE0000707	Grey seal	Underwater noise changes - UXO detonation	LSE cannot be ruled out / AA is required
Pembrokeshire Marine/ Sir Benfro Forol SAC UK0013116	Grey seal	Underwater noise changes	No potential for significant effects / AA is not required
West Wales Marine / Gorllewin Cymru Forol SAC - UK0030397	Harbour porpoise	Underwater noise changes	No potential for significant effects / AA is not required
Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC - UK0030396	Harbour porpoise	Underwater noise changes	No potential for significant effects / AA is not required
North Anglesey Marine / Gogledd Môn Forol SAC - UK0030398	Harbour porpoise	Underwater noise changes	No potential for significant effects / AA is not required
North Channel SAC - UK0030399	Harbour porpoise	Underwater noise changes	No potential for significant effects / AA is not required
Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau SAC - UK0013117	Bottlenose dolphin	Underwater noise changes	No potential for significant effects / AA is not required
Cardigan Bay/ Bae Ceredigion SAC - UK0012712	Bottlenose dolphin	Underwater noise changes	No potential for significant effects / AA is not required

5. Stage 2 – Appropriate Assessment Natura Impact Statement

The Stage 1 Screening documented in Section 4 concluded that there is the potential for likely significant adverse effects on the following three sites and that an AA is required:

- Hook Head SAC (site code: IE0000764)
- Saltee Islands SAC (site code: IE0000707)
- Slaney River Valley SAC (side code: IE0000781)

The AA is a focused and detailed impact assessment of the implications of the plan of project alone and in combination with other plans and projects, on the integrity of a Natura 2000 site in view of its conservation objectives. It is undertaken by the competent authority, which for Foreshore Licence applications is the Department of Housing, Planning and Local Government – Foreshore Unit. To inform the AA, the proponent of the plan (i.e. Greenlink Interconnector Limited) must provide a Natura Impact Statement (NIS) which provides data and information on the project and an analysis of potential effects on the Natura 2000 site.

NPWS guidance (2012) on the content of the Natura Impact Assessment states:

"The more detailed ecological assessment of proposed activities requires that two key questions be addressed: 'What are the likely impacts of the proposed activity?' and 'How quickly could the qualifying interest recover from the impact, if at all?'".

The guidance identifies specific questions which should be considered when providing information to support the AA.

This Natura Impact Statement draws on information provided in this document as identified in Table 5-1. It considers the three sites for which the potential for a likely significant effect has been identified and provides further assessment of the significant effects on the Qualifying Interests of these sites. Where appropriate it proposes mitigation measures which will be taken by GIL to reduce the significance of effects.

Table 5-1 Cross-reference to other supporting information

Relevant information	Section
Description of the Project	Section 2
Conservation objectives of the Natura 2000 site	Section 4.4
Assessment of aspects of the proposed project which could negatively affect the conservation objectives of the Natura 2000 site	Section 4.4

5.1 Hook Head SAC

5.1.1 Qualifying Interest - Reef

5.1.1.1 Screening conclusion

The AA screening identified that there is potential for a likely significant effect on the Qualifying Interest Reef from the following pressures:

- Penetration and/or disturbance including abrasion
- Physical change (to another seabed type)

The conservation objectives for the Qualifying Interest are:

To maintain the favourable conservation condition of Reefs in Hook Head SAC, which is defined by the following list of attributes and targets:

- Distribution: The distribution of reefs should remain stable, subject to natural processes.
- Habitat area: The permanent area is stable, subject to natural processes.
- Community Structure: The following reef community complexes should be maintained in a natural condition: Exposed to moderately exposed intertidal reef community complex; and Echinoderm and sponge dominated community complex.
- Community extent: The extent of Laminaria dominated community should be conserved, subject to natural processes.
- Community structure: The biology of Laminaria dominated community should be conserved, subject to natural processes.

The AA screening concluded that in relation to the conservation objectives cable trenching and the associated deposition of external cable protection across Bedrock Reef in the offshore area has the potential to reduce the habitat area and affect the community structure of the Qualifying Interest.

5.1.1.2 Assessment of effects

A detailed assessment of effects on Reef habitat has been provided in the Greenlink Marine EIAR – Ireland; Chapter 7. The assessment provided here summarises the pertinent information and relates it to the conservation objectives to determine if there will be a significant adverse effect on the SAC. For ease of reference, the Greenlink Marine EIAR – Ireland Chapter 7 has been provided as Appendix B in this NIS.

Bedrock Reef habitat was identified by the cable route survey within the Proposed Development. The location of the habitat in relation to the indicative centreline and Proposed Development boundaries is displayed in Appendix B, Figures 7-15 to 7-16 (Drawings P1975-HAB-004 Sheet 12 and P1975-HAB-004 Sheet 11).

The presence and location of the Reef habitat offshore was taken into consideration during the design (routeing) of the Proposed Development. INFOMAR bathymetry data and NPWS habitat maps were used to identify a suitable cable route through the Hook Head SAC that avoids crossing the Annex I habitat (see Table 2-2). Route engineering was undertaken during the marine survey to investigate options to further avoid outcropping rock features. This has led to the selection of the final route, shown as the indicative centreline within the Proposed Development. The worst case scenario is that the cables are laid across the Annex I habitat. This scenario is technically challenging due to the ground conditions, will require extensive external cable protection and will significantly increase installation costs. If this scenario had been considered the only viable method of installing the cables the route to Baginbun Beach would not have been selected. The Proposed Development (the design assessed) is therefore an installation corridor that avoids crossing the Annex I bedrock reef habitat offshore. The channel between the mapped Annex I habitat features is sufficiently wide to allow installation within the sandy sediments.

Although the Proposed Development will avoid the Bedrock Reef habitat through routeing it is acknowledged that the extent of the Proposed Development has not been refined to exclude the habitat from the application area. Screening for likely significant effects is undertaken prior to any mitigation being proposed and therefore as Bedrock Reef is present within the Proposed Development there is still a very small risk that during installation, activities that penetrate and/or disturb the habitat could be undertaken on the habitat. Intrusive activities e.g. cable trenching have the potential to reduce the extent of the habitat within the SAC and affect the community structure.

5.1.1.3 Cumulative effects

Stage 1 screening identified 14 projects, plans or activities within 10km of the Proposed Development. These were:

- Kilmore Quay Disposal Site
- Celtic (Telecom cable)
- Solas (Telecom cable)
- Pan European Crossing 1 (Telecom cable)
- ESAT 1 (Telecom cable)
- Eir (Fibre Optic)
- Wellhead 50/3-3
- Wellhead 50/3-1
- Wellhead 50/3-2
- Wellhead 50/2-1
- Seaweed harvesting

- Oyster beds
- ADCP deployment
- Celtic Sea Array

Screening for potential cumulative effects concluded that 12 projects could be screened out on the grounds that there was either no common pressure-receptor pathway or that the pressure-receptor pathways do not overlap spatially with the Proposed Development. The two projects taken forward in the assessment were the Celtic Sea Array survey and Kilmore Quay Disposal site. Neither of these projects overlap spatially with the Proposed Development within the Hook Head SAC. Therefore there is no potential for cumulative effects.

5.1.1.4 Summary of assessment

Table 5-2 Summary - Assessment of potential effect - Reef

Questions	Response
Is there likely to be an adverse impact to physical or chemical parameters, or principal biological communities of the Annex I habitat?	No The Greenlink cable route survey has identified areas of Bedrock Reef habitat within the Proposed Development. The indicative cable centerline has been designed to avoid the habitat by following a sediment channel.
How does that impact arise in relation to the proposed development?	The cable route has been designed to avoid areas of Bedrock Reef. The Installation Contractor will undertake the final design of the cable route within the Proposed Development. There is a very low likelihood that they could seek a route across the Bedrock Reef. This is highly unlikely as it would involve cutting and the deposit of external cable protection, both costly techniques. A contract condition will be imposed on the Installation Contractor to remove this risk (Section 5.1.1.5).
How are the existing physical, chemical and/or biological aspects of the qualifying interest likely to be impacted?	Effects on the Qualifying Interest have been avoided through route and engineering design.
What is the likely duration of the impact?	No effects.
Where applicable, how quickly are the biological communities likely to recover once the operation/activity has ceased?	No effects.
In the absence of mitigation, are the physical, chemical or biological impacts of the proposed operation/activity likely to have a significant effect on the favourable conservation condition or relevant conservation targets (where available) of the Annex I habitat at the site?	The pressure-receptor pathway between the Proposed Development and the Qualifying Interest has been removed through route design and engineering.
Is there the potential for cumulative effects with other plans or projects?	No PCEs between the Proposed Development and any other known projects or plans have been identified.

5.1.1.5 What measures can be implemented to mitigate the significance of the likely adverse impact into insignificance?

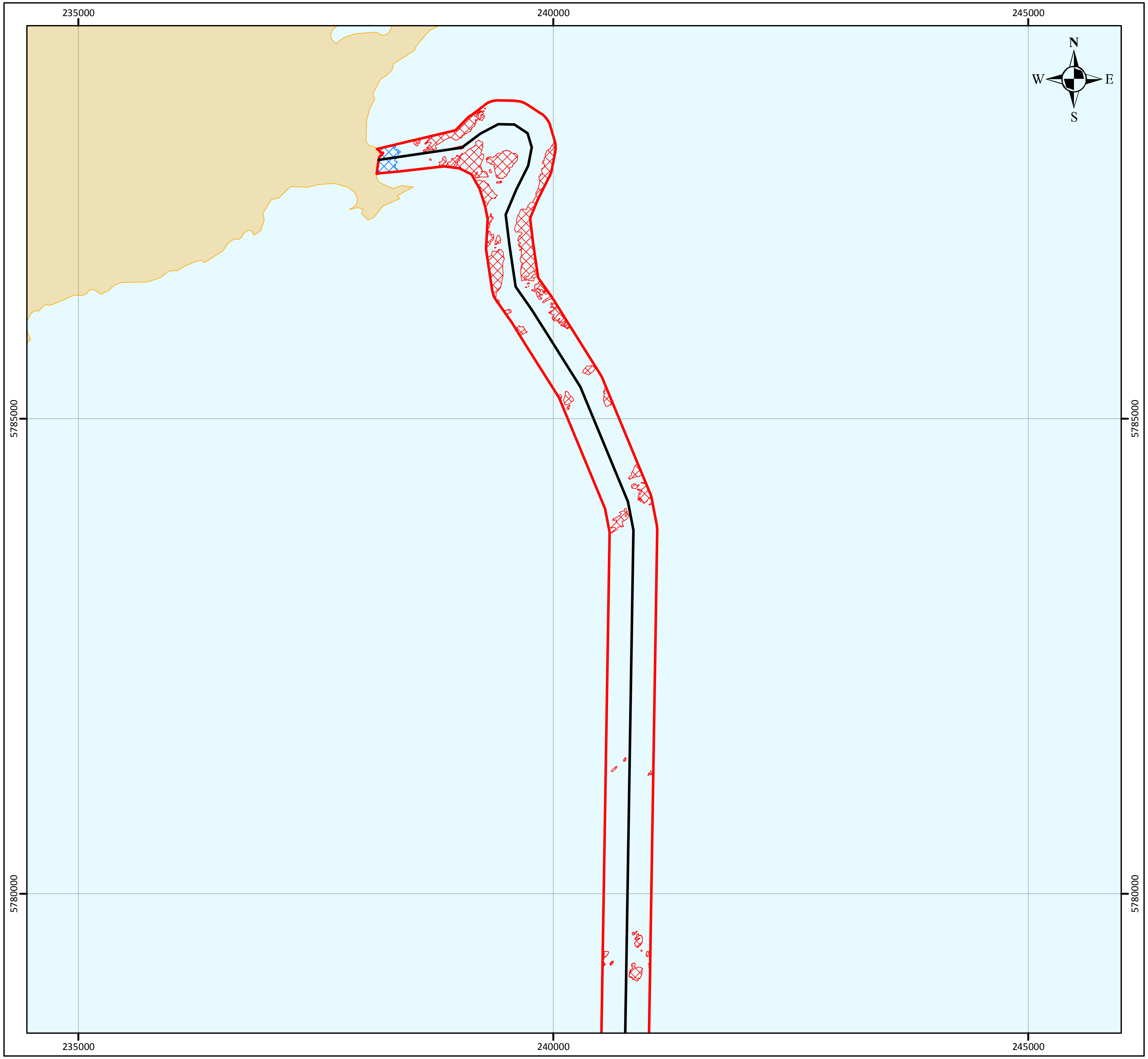
The Proposed Development is optimised to avoid the Qualifying Interest Bedrock Reef habitat offshore, by following a sediment channel. An HDD exit target area has been prescribed which will ensure that the cable trenching avoids the Bedrock Reef habitat that fringes Baginbun Beach and extends across the Proposed Development.

To ensure there will be no effect on the Qualifying Interest, exclusion zones will be established around the Bedrock Reef habitat within the Proposed Development. Shown on Figure 5-1, Drawing P1975-INST-008, no intrusive works (e.g. cable installation, deposits of external cable protection material) will be permitted within these exclusion zones. GIL will ensure that the Installation Contractor adheres to these exclusions. Implementation of the exclusion zones, combined with the route and engineering design will result in the pressure pathway to the habitat being removed.

5.1.1.6 Conclusion

It is possible that the Qualifying Interest 'Reef' could be disturbed by cable trenching and external cable protection as it is present within the Proposed Development. The deposition of external cable protection or cutting of the rock has the potential to reduce the extent and community structure of the Qualifying Interest. Therefore, to avoid significant adverse effects, GIL has committed to establishing exclusion zones around the habitat. Implementation of the exclusion zones will result in the pressure pathway to the habitat being removed and subsequently there will be no adverse effects on the conservation objectives of the Qualifying Interest. In light of this, it is concluded that the Proposed Development will not have an adverse effect on the integrity of the Hook Head SAC either alone or in combination with other plans or projects.

Conclusion – No adverse effect on integrity of site, either alone or in combination with other plans or projects.



GREENLINK INTERCONNECTOR
INSTALLATION
Annex I Habitat Exclusion Zones - ROI Route

Drawing No: P1975-INST-008	A

Legend

- Indicative Greenlink Route Centreline
- Proposed Development
- Annex I Habitat Exclusion Zone
- Trenching Exclusion Zone

NOTE: Not to be used for Navigation

Date	Monday, April 29, 2019 14:14:29
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSI; MMT; ESRI; Greenlink
File Reference	J:\P1975\Mxd\15_INST\ P1975-INST-008.mxd
Created By	Chris Goode
Reviewed By	Chris Carroll
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

intertek

0 500 1,000 1,500 2,000 m

5.1.2 Qualifying Interest - large shallow inlets and bays

5.1.2.1 Screening conclusion

The AA screening identified that there is potential for a likely significant effect on the Qualifying Interest Annex I habitat 'large shallow inlets and bays' from the following two pressures:

- Penetration and/or disturbance including abrasion
- Physical change (to another seabed type)

The conservation objectives for the Qualifying Interest are:

To maintain the favourable conservation condition of large shallow inlets and bays in Hook Head SAC, which is defined by the following list of attributes and targets: • Habitat area: The permanent area is stable or increasing, subject to natural processes. • Community extent: The following communities should be maintained in a natural condition: Sand with *Chaetozone christiei* and *Tellina* sp. community; and Coarse sediment with *Pisidia longicornis* and epibenthic fauna community complex.

The AA screening concluded that in relation to the conservation objectives the deposition of external cable protection at the HDD exit points, if required, could reduce the community extent of the Qualifying Interest.

5.1.2.2 Assessment of effects

__Background Information:__

A detailed assessment of effects on large shallow inlets and bays has been provided in the Greenlink Marine EIAR – Ireland; Chapter 7 Benthic and Intertidal Ecology. The assessment provided here summarises the pertinent information and relates it to the conservation objectives to determine if there will be a significant adverse effect on the SAC. For ease of reference, the Greenlink Marine EIAR – Ireland Chapter 7 has been provided as Appendix B in this NIS.

Large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. Several of these habitat types (1140 Mudflats and sandflats not covered by sea water at low tide, 1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs) are listed as Annex I habitats in their own right. The Annex I habitat within the Hook Head SAC comprises:

- Sand with *Chaetozone christiei* and *Tellina* sp. community;
- Coarse sediment with *Pisidia longicornis* and epibenthic fauna community complex; and
- Reef (listed as a separate Qualifying Interest).

A habitat complex is designated as a Qualifying Interest when an area possesses similar features but records a number of biological communities that overlap significantly. The habitat is a broad sedimentary community.

Areas classified as large shallow inlets and bays along the Proposed Development are displayed on Figures 7-15 and 7-16 (P1975-HAB-004 Sheet 11 and Sheet 12) in Appendix B.

The plan being assessed is that as a contingency a very small quantity of external cable protection (20m x 5.2m by 0.7m high) will be used at two HDD exit points to protect the cables before they can be bundled together and trenched. The external cable protection will likely consist of rocks between 2 and 22cm in diameter.

The potential for significant effects on each of the conservation objectives is discussed in turn below.

Habitat area:
The cable route survey has established that sediments in the nearshore form a shallow sediment unit over bedrock. The sediment unit deepens with depth. If the HDD ducts exit in the shallower sediments it is possible that the required depth of burial for the cables will not be achieved. In this scenario, a small volume of external cable protection could be required at the HDD exit points.

At the HDD exit points the surficial sediments consists of A5.23 Infralittoral fine sand. It lies within an area classified by NPWS as the community 'Sand with *Chaetozone christiei* and *Tellina* sp. community', which lies between the 3m and 15m water depth. The external cable protection would constitute a significant localised coarsening of the sand and will effectively change the seabed sediment type to a hard substrate.

The Natura 2000 form for the site (NATURA 2000 2018) records that the Qualifying Interest covers an area of 52.44km^2 (5243.8404 hectares); of this NPWS (2011) estimates the area covered by 'Sand with *Chaetozone christiei* and *Tellina* sp. community' as 5.75km^2 (575 hectares).

The footprint of the external cable protection (208m^2) is equivalent to 0.0004% of the Qualifying Interest and 0.004% of the 'Sand with *Chaetozone christiei* and *Tellina* sp. community'. This is a negligible reduction in the extent of the habitat. This conclusion is supported by NPWS (2011) which states "licensing of activities likely to cause continuous disturbance of each community type should not exceed an approximate area of 15%." It is recognised that this statement relates to continued disturbance, however removal of the habitat is also analogous to continued disturbance as both scenarios will not allow the community to recover.

The deposit of the external cable protection, if required, will form a new hard substrate. Subtidal rock habitat is reported as being more diverse than subtidal sand habitat which is generally described as species poor (Natural England 2012). Therefore, evidence suggests that in the medium-term, it is likely that the colonised external cable protection will be more diverse than the existing Infralittoral fine sand.

If required, external cable protection will run perpendicular to the shore and will essentially form two small islands (both of which will be 5.2m wide and 20m long) in the middle of a larger sand habitat. Therefore, external cable protection will not be of sufficient size to form a barrier across the sand channel and will not cause fragmentation of the sand habitat.

The Qualifying Interest 'large shallow inlets and bays' encompasses the Annex I habitat 'Reef'. The new substrate will be more in line with the 'reef' classification when it is colonised (see discussion below on community extent). Therefore, given the reduction in size is negligible and reclassification to a different part of the habitat complex, the overall extent of the Annex I habitat shallow inlets and bays will not be adversely effected and there will be no significant effect on the conservation objective.

Community extent:
External cable protection in infralittoral sand will result in a localised coarsening of sediments. Where external cable protection is used in A5.23 Infralittoral fine sand, the habitat in the footprint of the berm will be lost and replaced with harder substrate, changing the seabed type. The Marine Life Information Network (MarLIN) sensitivity assessment for a similar habitat type (*Arenicola marina* in infralittoral fine sand or muddy sand) concludes that the sensitivity of the habitat to the pressure physical change (to another seabed type) is high. This is based on the fact a change to an artificial or rock substratum would alter the character of the biotope leading to reclassification. The deposition of external cable protection at the HDD exits therefore has the potential to reduce the extent of the 'Sand with *Chaetozone christiei* and *Tellina* sp. community'.

The external cable protection will form two narrow localised deposits. As discussed above, due to its small size and position, it will not act as a barrier or act to fragment the surrounding 'Sand with *Chaetozone christiei* and *Tellina* sp. community'.

The sand habitat within the footprint will be replaced by a hard substrate and so will not recover. However, the external cable protection will form a new habitat, which could in the medium-term be more diverse than the existing infralittoral fine sand. The Qualifying Interest 'large shallow inlets and bays' encompasses the Annex I habitat 'Reef'. The new substrate formed would be more in line with the 'reef' classification when it is colonised.

Evidence from post-construction monitoring of windfarm scour protection indicates that rock berms installed in sandy sediments are colonised by epifauna.

Case Studies on the Offshore Windfarm Egmond aan Zee, Prinses Amalia Wind Farm and Horns Rev Wind Farm found that the density of species on scour protection areas were high and the number of species observed increased with time. In addition, in many cases the number of rare species had also increased (Waardenburg et al 2017). Studies (Lindeboom et al 2011) at OWEZ identified 11-17 hard substratum benthos species on the rock material. At the Horns Rev wind farm the scour protection has been colonised by sea anemones and the soft coral *Alcyonium digitatum* (Langhamer 2012). Monitoring of the Nord Stream pipeline in Swedish waters showed that over a period of four years a general increase in epifauna was seen on the introduced hard substrate (pipeline and rock berms) (Nord Stream 2014).

The colonisation of the hard substrate will be dependent on the passive transport of adult organisms or the availability of larvae from the surrounding region. However, in the examples provided above, the rock was introduced into areas of soft substrate and colonisation of the external cable protection material has occurred. It can therefore be assumed, given that Bedrock Reef habitat is a maximum of 300m away from any potential HDD exit points, that colonisation of the rock berms can be expected. This is supported by the cable route survey which shows the areas of bedrock separated from the main reef e.g. within the sediment channel, also support reef community.

Based on the case studies provided above and the position of external cable protection, it is concluded that the deposited material will be colonised.

The reef habitat in the area is classed as EUNIS habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds. A study looking into the colonization of a newly created rocky shore in the Moray Firth found that limpets and barnacles were observed after 3-4 years (MarLIN 2019). A study by Hawkins & Southward (1992) (referenced in MarLIN 2019) found that, after the Torrey Canyon oil spill, it took between 10 and 15 years for the Fucus sp. to return to 'normal' levels of spatial and variation in cover on moderately exposed shores. This suggests colonisation will occur in the medium-term.

External cable protection deposits could be viewed as an artificial reef. The OSPAR Commission (2009) defines an artificial reef, as a ‘submerged structure placed on the seabed deliberately, to mimic some characteristics of a natural reef. It could be partly exposed at some stages of the tide’. This places the external cable protection material outside the formal definition on the basis of purpose. However, almost all man-made structures placed on the seabed are rapidly and quickly colonised by marine organisms (Linley et al 2008). The effects of artificial reefs are ambiguous with Linley et al (2008) citing studies such as Ambrose and Anderson (1990) which have shown that some species of infauna were enhanced whilst others were depressed. It is therefore acknowledged that whilst the external cable protection could enhance the productivity and biodiversity of the habitat, it will also represent a variation on the habitat that was previously there.

As discussed above, large shallow inlets and bays comprise an independent mosaic of intertidal and subtidal habitat, including both reef and sand habitat. Therefore, whilst cable protection will lead to a minor reduction in the area of sand habitat within the SAC (equivalent to 0.0002% of the Qualifying Interest) it will also lead to a minor increase in reef habitat (0.002km^2). In addition, reef habitat has a higher diversity of species than impoverished sand habitat, therefore external cable protection could result in a minor contribution to the diversity of 'large shallow inlets and bays'.

It is therefore concluded that, although external cable protection will result in a minor reduction in sand habitat, it will not significantly affect the conservation objective (community structure) of shallow inlets and bays, as in the medium-term external cable protection will result in a minor increase in reef habitat.

5.1.2.3 Cumulative effects

Stage 1 screening identified 14 projects, plans or activities within 10km of the Proposed Development. These were:

- Kilmore Quay Disposal Site
- Celtic (Telecom cable)
- Solas (Telecom cable)
- Pan European Crossing 1 (Telecom cable)
- ESAT 1 (Telecom cable)
- Eir (Fibre Optic)
- Wellhead 50/3-3
- Wellhead 50/3-1
- Wellhead 50/3-2
- Wellhead 50/2-1
- Seaweed harvesting
- Oyster beds
- ADCP deployment
- Celtic Sea Array

Screening for potential cumulative effects concluded that 12 projects could be screened out on the grounds that there was either no common pressure-receptor pathway or that the pressure-receptor pathways do not overlap spatially with the Proposed Development. The two projects taken forward in the assessment were the Celtic Sea Array survey and Kilmore Quay Disposal site. Neither of these projects overlap spatially with the Proposed Development within the Hook Head SAC. Therefore there is no potential for cumulative effects.

5.1.2.4 Summary of assessment

Table 5-3 Summary - Assessment of potential effect – Large shallow inlets and bays

Questions	Response
Is there likely to be an adverse impact to physical or chemical parameters, or principal biological communities of the Annex I habitat?	Yes Where external cable protection is used the seabed habitat within the footprint of the rock berms will be lost and replaced with harder substrate, changing the seabed type. This could adversely affect the sand habitat associated with Annex I habitat large shallow inlets and bays.
How does that impact arise in relation to the proposed development?	As a contingency, the assessment considers to deposit of a very small quantity of external cable protection (20m long x 5.2m wide by 0.7m high) at the both of the HDD exit points to protect the cables before they can be bundled together and trenched.
How are the existing physical, chemical and/or biological aspects of the qualifying interest likely to be impacted?	Where external cable protection is used in A5.23 Infralittoral fine sand, the habitat in the footprint of the berms will be lost and replaced with harder substrate, changing the seabed type. The deposition of external cable protection therefore has the potential to reduce the community extent.
What is the likely duration of the impact?	Permanent change.
Where applicable, how quickly are the biological communities likely to recover once the operation/activity has ceased?	The sand habitat will be replaced by a hard substrate and so will not recover. However, external cable protection will form a new habitat, which could in the medium-term be more diverse than the existing Infralittoral fine sand. The Qualifying Interest 'large shallow inlets and bays' encompasses the Annex I habitat 'Reef'. The new substrate formed will be more in line with the 'reef' classification when it is colonised.
In the absence of mitigation, are the physical, chemical or biological impacts of the proposed operation/activity likely to have a significant effect on the favourable conservation condition or relevant conservation targets (where available) of the Annex I habitat at the site?	In the absence of mitigation external cable protection in infralittoral fine sand will result in a localised but long-term alteration to the community structure of the habitat. In addition, the change in habitat type will lead to the reclassification of the localised area as reef. Reef is one of the habitats that make up the Large shallow inlets and bay habitat complex, and could potentially be of higher ecological value as stony reefs support more diverse communities.
Is there the potential for cumulative effects with other plans or projects?	No PCEs between the Proposed Development and any other known projects or plans have been identified.

5.1.2.5 What measures can be implemented to mitigate the significance of the likely adverse impact into insignificance?

The Proposed Development has been optimised to reduce the likelihood of external cable protection being required at the HDD exit points. A target area for the HDD has been defined, starting at the 9m water depth contour, where analysis of geophysical data indicates sediment are of sufficient depth to facilitate cable burial.

GIL will indicate their preference to bury the HDD exit ducts and all cables in sediment to the required depth of lowering by passing on Project Specific Mitigation to the Installation Contractor as follows:

"The preference is to bury the HDD ducts exit and all cables in sediment to the required depth of lowering. To achieve this the Installation Contractor should seek to engineer the HDD to exit in thick sediment in order that the ducts can be trenched back down to beneath the seabed level. If the required depth of burial cannot be achieved in sediment, then some external protection will be required. Taking into consideration the exact HDD exits, the footprint of external protection should be the minimum required for burial. To achieve this, consideration should be given to undertaking part sediment burial, and part external protection; use of concrete mattresses (i.e. to reduce berm height), or other engineering solutions that reduce the footprint of external cable protection (both vertically and horizontally). If there is no technically feasible alternative the exact position, nature of and final defined size of external cable protection will be communicated to the Foreshore Unit, NPWS and Irish Maritime Administration and local fishermen."

5.1.2.6 Conclusion

If external cable protection is required at the HDD exit points, the extent of the 'Sand with *Chaetozone christiei* and *Tellina* sp. community' part of the Qualifying Interest 'Shallow inlets and bays' will be marginally reduced. Therefore, the preference is to bury the HDD exit ducts and all cables in sediment to the required depth of lowering. Design of the Proposed Development has sought to reduce the likelihood of the contingency being required (e.g. locating the potential HDD exits in water depths greater than 9m where the sediment unit is thicker) and Project Specific Mitigation will be implemented to ensure that the Installation Contractor seeks further opportunities to consider alternatives or reduce the footprint of the deposit. Although there will be a reduction of the habitat 'Sand with *Chaetozone christiei* and *Tellina* sp. community' in the medium-term colonisation of the external cable protection will lead to an increase in the Reef habitat. The change in habitat will not significantly affect the conservation objectives of the SAC.

In light of this, it is concluded that the Proposed Development will not have an adverse effect on the integrity of the Hook Head SAC either alone or in combination with other plans or projects.

Conclusion – No adverse effect on integrity of site, either alone or in combination with other plans or projects.

If the contingency external cable protection is used at the HDD exits, then an environmental monitoring plan will be established to monitor colonisation of the external cable protection.

It is proposed that this will be conducted using drop-down video transects. A control transect should be established on the adjacent Annex I reef to establish a baseline for community diversity. The length of the external cable protection will also be surveyed. Monitoring would be planned to coincide with the first two routine cable inspection surveys. It is expected that the first inspection survey will be undertaken within the first three years of installation, with a second survey undertaken within three years of the first survey. All footage will also be reviewed for the presence of invasive non-native species.

The objectives of monitoring colonisation of the external cable protection will be to establish an evidence base to confirm the conclusion that the deposition of the external protection material adds to the Reef habitat within the Hook head SAC.

It is recognised that monitoring will not mitigate any effects but it is considered best practice to support a scientific evidence base to inform future decision making across other industries. The results of the monitoring will be sent to NPWS.

5.2 *Saltee Islands SAC*

5.2.1 *Screening conclusion*

The AA screening identified that there is potential for a likely significant effect from underwater sound on grey seal from this site, if UXO detonation were to occur.

The conservation objective is:

To maintain the favourable conservation condition of Grey Seal in this SAC, which is defined by the following lists of attributes and targets:

a. Access to suitable habitat – Target 1 species range within the site should not be restricted by artificial barriers to site use.
b. Breeding behaviour – Target 2 The breeding sites should be maintained in a natural condition.
c. Moulting behaviour – Target 3 The moult haul-out sites should be maintained in a natural condition.
d. Resting behaviour – Target 4 The resting haul-out sites should be maintained in a natural condition.
e. Population composition – Target 5 The grey seal population occurring within this site should contain adult, juvenile and pup cohorts annually
f. Disturbance – Target 6 Human activities should occur at levels that do not adversely affect the grey seal population

The AA screening concluded that in relation to the conservation objectives, UXO detonation will not affect breeding, moulting and resting behaviour of grey seal in the site nor would it act as an artificial barrier to seals moving on and off the site i.e. Attributes A-D and Targets 1-4. However, if a number of adults and juveniles from the SAC are within the water and the zone of influence at the time of UXO detonation, they could be killed or injured which could disrupt the ratio of adults and juveniles within the site, effecting Attributes E and F and Targets 5 and 6.

5.2.2 Assessment of effects

Questions	Response
Will the proposed operation or activity result in death, injury or disturbance of individuals?	Yes. If UXO detonation is required the large and sudden pressure change could cause permanent and temporary injury to grey seal within 17km of the detonation. In addition, seals within 54km could be disturbed by the brief but significant underwater noise change.
Is it possible to estimate the number of individuals that are likely to be affected	Not with certainty. As a mobile species that range over a large area, it is not possible to estimate with certainty how many grey seals from this site could be within the water and zone of influence at the time of a UXO detonation. The population estimate for the SAC is 571-734 individuals (NPWS 2017). This population estimate is based on the pup production (i.e. the number of pups born) for 2005; an estimated 163 pups were born in the Saltee Islands SAC in 2005 (NPWS 2011). Grey seal sightings are common with between 5-10 individuals per 5km^2 within the Proposed Development increasing to 10-50 animals per 5km^2 within the Saltee Islands SAC (Russell et al 2017). As the SAC is 6.1km from the Proposed Development, the 17km zone of injury will potentially effect 123km^2 of the SAC. Using the density estimates provide above this could mean that between 246 animals and 1230 animals could be within the zone of influence. As the upper estimate is significantly above the population estimate for the SAC this demonstrates the difficulty in predicting numbers of animals in the water at any one time. As the zone of influence for disturbance is wider than the SAC boundary it would also mean that the whole population could be subject to brief disturbance, but again this is highly unlikely as not all animals will be in the water at the same time. Grey seal will be most vulnerable to UXO detonation during summer months (May – August) when they are in the water. From August through to December animals are likely to be hauled up on beaches for pupping.
Will individuals be disturbed at a sensitive time or location during their life cycle	Unlikely. The sensitive time for grey seal at the site will be during breeding (August to December), moulting (December – February) and resting (all year). The thresholds for injury are for pinnipeds in water. Animals engaged in the activities listed above will be hauled-out on beaches out of the water. Therefore, noise generated by UXO detonation will not affect breeding, moulting and resting. Sound in air will be a brief event, a minimum of 6.1km distance away. Although the exact location of a UXO detonation (if required) is unknown, the closest haul out sites to the Proposed Development are Saltee Islands (10.7km) and Coningmore Rocks (10.8km). It is highly unlikely that this would adversely affect seal that are hauled out engaged in breeding, resting and moulting behavior.
Are the effects likely to focus on a particular section of the	No. It is possible that both sexes of juveniles and adults could be within the zone of influence during UXO detonation (if required).

Questions	Response
population, e.g., adults vs. juveniles, males vs. females	
Will the operation/activity cause displacement from key functional areas	No. Underwater noise activities will not displace seal. The UXO detonation, if required, will be a brief one-off event and any animals disturbed by the sudden but brief underwater noise change will be able to return to the area rapidly.
Is the habitat of the species likely to deteriorate causing disturbance to individuals or populations	No. The change in underwater noise will be brief and will not effect grey seal habitat.
How quickly is the affected population in the SAC likely to recover once the operation/activity has ceased	If required UXO detonation will be a brief one-off event (less than one day). The SAC is within the zone of influence for injury and disturbance. It is not possible to determine how many grey seal could be injured or killed from UXO detonation. The breeding population was estimated at 571-744 individuals in 2005. The site is within the zone of influence for temporary and permanent injury which suggests that, as a worst-case, numbers of animal in the water could be high and effects could be significant. If sufficient numbers of animals were injured there could be a long-term effect on the population. It is not possible to determine how quickly the population will recover, given that exact numbers effected cannot be confidently predicted.
In the absence of mitigation, are the effects of the proposed operation/activity on Annex II species likely to have a significant effect on the favourable conservation condition of the Annex II species at the site	In the absence of mitigation, it is possible that noise generated from UXO detonation would lead to a significant effect on Attribute E, Target 5 and Attribute F, Target 6. If UXO detonation occurs at a time when a significant proportion of the grey seal population are within the water, then this could disrupt the population composition of the site.

5.2.3 Cumulative effects

Stage 1 screening identified 14 projects, plans or activities within 10km of the Proposed Development. These were:

- Kilmore Quay Disposal Site
- Celtic (Telecom cable)
- Solas (Telecom cable)
- Pan European Crossing 1 (Telecom cable)
- ESAT 1 (Telecom cable)
- Eir (Fibre Optic)
- Wellhead 50/3-3
- Wellhead 50/3-1
- Wellhead 50/3-2

- Wellhead 50/2-1
- Seaweed harvesting
- Oyster beds
- ADCP deployment
- Celtic Sea Array

Screening for potential cumulative effects concluded that 12 projects could be screened out on the grounds that there was either no common pressure-receptor pathway or that the pressure-receptor pathways do not overlap spatially with the Proposed Development. The two projects taken forward in the assessment were the Celtic Sea Array survey and Kilmore Quay Disposal site. Kilmore Quay Disposal site was screened out as there is no temporal overlap with the Proposed Development; the project will be finished prior to the Proposed Development starting.

However there is scope for cumulative effects between the Celtic Sea Array survey and the Proposed Development. Neither project crosses the Saltee Islands SAC but the Celtic Sea Array will be 1km to the west at the closest point of approach, whilst the Proposed Development is 6.1km to the west.

Screening concluded that there is the potential for a cumulative effect if survey activities from the Proposed Development and Celtic Sea Array occur consecutively. It is unlikely that they will occur simultaneously as given the close proximity the geophysical signals would interfere with each other. However, the assessment concluded that effects will not be significant. Celtic Sea Array is not planning any UXO clearance or detonation.

The UXO detonation for the Proposed Development, if required, will be a one-off event. The noise change from the detonation will be significant but brief. It will act independently of any noise changes as a consequence of the Celtic Sea Array and will be the more significant of the two sound sources. The potential cumulative effect has been assessed as not significant given the Proposed Development will be the more significant of the two activities and the brief nature of the event.

5.2.4 What measures can be implemented to mitigate the significance of the likely adverse effects into insignificance?

The most effective mitigation is to avoid the need for detonation completely. Design constraints within the project (Table 2-2) seek to do this by establishing a decision making strategy in which UXO detonation is the last option. If UXO detonation is the only feasible option, the target could either be detonated in-situ (typically the preferred option for health and safety reasons); or relocated on the seabed and then detonated. Relocation could occur when detonating in-situ would compromise the safety of Greenlink, third party assets or the public, or where one UXO is relocated close to another to allow a single detonation to take place.

For UXO detonation GIL will follow the DAHG (2014) Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (see Table 2-2). However, to further reduce the significance of the effect GIL has selected a range of project-specific mitigation measures, as described below which will be implemented.

In consultation with DHPLG – Foreshore Unit and NPWS, acoustic deterrent devices (ADDs) will be selected and deployed. ADDs will be activate 20 to 60 minutes prior to UXO detonation dependant on the UXO charge size. ADDs are used to exclude animals from a mitigation zone and are used in conjunction with visual and / or acoustic monitoring and should normally be used for as short period as necessary to minimise the introduction of additional noise. These devices emit medium to high frequency sounds that deter animals from injury zones. They have been widely used by offshore industries during pile-driving, and at windfarms for UXO clearance activities (McGarry et al. 2018). McGarry et al. (2018) observed that fleeing individuals were at least 1,500 m from the sound source when exposed to the ADD for 15 minutes. It is therefore considered that the use of ADDs combined with marine mammal observations for this purpose would be more effective than traditional passive mitigation methods.

The use of Passive Acoustic Monitoring (PAM) systems has also been identified as a further mitigation measure which GIL will adopt if required. PAM is a software system that utilises hydrophones to detect the vocalisations of marine mammals. It is useful during periods of darkness, poor visibility or when the sea state is not conducive to visual mitigation. A PAM system would be used to support the marine mammal visual observations and will be used during periods of darkness and/or poor visibility. It would be operated by a suitably trained and experienced marine mammal observer (MMO). The PAM system typically comprises signal processing equipment located in a control room, an intermediary deck cable, and a towing cable terminating with a hydrophone array. The PAM system would be optimised for the real-time detection (i.e. live visual display and audible output) of marine mammals know to be present within the Proposed Development. A PAM system could be used in conjunction with ADDs – this would enable the MMO to monitor the presence or absence of pinniped within the zone of influence prior to detonating any UXO.

If the UXO identified is great than 10kg than a soft-start procedure will also be used in combination with the ADDs. In this scenario, the marine mammal observers would conduct a pre-start search, the ADDs would be activated and then a sequence of small to large charges would be implemented to allow additional time for marine mammals to leave the area of potential effect. Typically, charges of 50g, 100g, 150g and 200g would be deployed 5 minutes after the deactivation of the ADD, and would be sequenced to commence at 5 minute intervals, with the a further 5 minute interval before the detonation of the UXO. An additional 250g charge may be added to the sequence if the UXO requiring detonation is greater than 250kg. This soft start procedure would give a minimum deterrence time of 50 minutes (25 minutes ADD and 25 minutes soft start) prior to detonation. Based on a swimming speed of

1.5m/s (Otani et al 2000) marine mammals should clear a radius of 4.5km over this duration.

Whilst this range is not beyond the predicted range of effect for injury, it must be noted that the predicted ranges are based on highly conservative assumptions. No consideration has been given to the effects bathymetry, seabed sediments and temperature and salinity profiles will have on propagation; all which will attenuate sound, reducing the range of effect. In addition, the noise level at the water's surface (where marine mammals are expected to be fleeing) would be much lower than modelling suggests. This point is supported by von Benda-Beckmann et al (2015) which cites uncertainty in predicted impact ranges beyond 2km due to calculations not considering the effects of cavitation and wind-generated bubbles which supports attenuation. Taking this into account, this Industry Best Practice is considered appropriate.

5.2.5 Conclusion

It is possible that grey seal from this site could be located in the water and zone of influence at the time of UXO detonation. If grey seal are killed or injured, this could disrupt the population composition of the site. Given the uncertainties in determining the number of grey seal which could be effected, if UXO is required, measures will be implemented in line with Industry Best Practice for UXO detonation. Implementation will reduce the significance of the effect to a level whereby the conservation objectives of the SAC will not be adversely affected.

One other project has been identified in the region, Celtic Sea Array survey that has the potential to interact with the Proposed Development in a manner that could cause a cumulative effect. The assessment concluded that the cumulative effect will not be significant.

In light of this, it is concluded that the Proposed Development will not have an adverse effect on the integrity of the Saltee Islands SAC either alone or in combination with other plans or projects.

Conclusion – No adverse effect on integrity of site, either alone or in combination with other plans or projects.

5.3 Slaney River Valley SAC

5.3.1 Screening conclusion

The AA screening identified that there is potential for a likely significant effect from underwater sound on harbour seal from this site, if UXO detonation were to occur. The conservation objective is to maintain the favourable conservation condition of harbour seal in the Slaney River Valley SAC, which is defined by the following list of attributes and targets:

a. Access to suitable habitat: Target 1 Species range within the site should not be restricted by artificial barriers to site use.

b. Breeding behaviour: Target 2 The breeding sites should be maintained in a natural condition.
c. Moulting behaviour: Target 3 The moult haul-out sites should be maintained in a natural condition.
d. Resting behaviour: Target 4 The resting haul-out sites should be maintained in a natural condition.
e. Disturbance: Target 5 Human activities should occur at levels that do not adversely affect the harbour seal population at the site.

The AA screening concluded that in relation to the conservation objectives, UXO detonation will not affect breeding, moulting and resting behaviour of harbour seal in the site nor would it act as an artificial barrier to seals moving on and off the site i.e. Attributes A-D and Targets 1-4. However, if a number of harbour seal from the SAC are within the water and the zone of influence at the time of UXO detonation, they could be killed, injured or disturbed which could affect the harbour seal population at this site, effecting Attribute E and Target 5.

5.3.2 Assessment of effects

Questions	Response
Will the proposed operation or activity result in death, injury or disturbance of individuals?	Yes. If UXO detonation is required the large and sudden pressure change could cause permanent and temporary injury to harbour seal within 17km of the detonation. In addition, seals within 54km could be disturbed by the brief but significant underwater noise change.
Is it possible to estimate the number of individuals that are likely to be affected	Not with certainty. As a mobile species that range over a large area, it is not possible to estimate with certainty how many harbour seal from this site could be within the water and zone of influence at the time of a UXO detonation. A total of 17 harbour seal were recorded ashore within the SAC during a national aerial survey for the species in August 2003. Additional records from within the site comprised 22 seals of all ages ashore in early September 2007 and 27 in early September 2009. Harbour seal sightings are infrequent within the Proposed Development suggesting numbers will be low. Harbour seal will be least vulnerable to UXO detonation during summer months (June – August) when they will be hauled up on sandbanks for breeding and moulting
Will individuals be disturbed at a sensitive time or location during their life cycle	Unlikely. The sensitive time for harbour seal at the site will be during breeding, moulting and resting. Animals engaged in the activities will be hauled-out on beaches out of the water. The thresholds for injury are for pinnipeds in water. Therefore, noise generated by UXO will not effect breeding, moulting and resting.

Questions	Response
	In addition, given the distance of Slaney River Valley SAC (29.7km) from the Proposed Development it is unlikely that breeding, resting and moulting behavior will not be effected.
Are the effects likely to focus on a particular section of the population, e.g., adults vs. juveniles, males vs. females	No. It is possible that both sexes of juveniles and adults could be in zone of influence during potential UXO detonation.
Will the operation/activity cause displacement from key functional areas	No. Underwater noise activities will not displace seal. The UXO detonation, if required, will be a brief one-off event and any animals disturbed by the sudden but brief underwater noise change will be able to return to the area rapidly.
Is the habitat of the species likely to deteriorate causing disturbance to individuals or populations	No. The change in underwater noise will be brief and will not affect grey seal habitat.
How quickly is the affected population in the SAC likely to recover once the operation/activity has ceased	If required UXO detonation will be a brief one-off event (less than one day). The SAC is outside the zone of influence for injury so it is unlikely that a significant number of the population will be present within the zone of influence for the conservation objectives of the site to be adversely effected. It is not possible to determine how quickly the population will recover if individuals are lost, given that exact numbers effected cannot be confidently predicted.
In the absence of mitigation, are the effects of the proposed operation/activity on Annex II species likely to have a significant effect on the favorable conservation condition of the Annex II species at the site	In the absence of mitigation, it is uncertain if noise generated from UXO detonation could lead to a significant effect on the favorable conservation objective of harbour seal in this SAC. If UXO detonation occurs at a time when a significant proportion of the harbour seal population from this site are within the water, then this could adversely affect the population at the site.

5.3.3 Cumulative effects

Stage 1 screening identified 14 projects, plans or activities within 10km of the Proposed Development. These were:

- Kilmore Quay Disposal Site
- Celtic (Telecom cable)
- Solas (Telecom cable)
- Pan European Crossing 1 (Telecom cable)
- ESAT 1 (Telecom cable)
- Eir (Fibre Optic)
- Wellhead 50/3-3
- Wellhead 50/3-1

- Wellhead 50/3-2
- Wellhead 50/2-1
- Seaweed harvesting
- Oyster beds
- ADCP deployment
- Celtic Sea Array

Screening for potential cumulative effects concluded that 12 projects could be screened out on the grounds that there was either no common pressure-receptor pathway or that the pressure-receptor pathways do not overlap spatially with the Proposed Development. The two projects taken forward in the assessment were the Celtic Sea Array survey and Kilmore Quay Disposal site. Kilmore Quay Disposal site was screened out as there is no temporal overlap with the Proposed Development; the project will be finished prior to the Proposed Development starting.

Due to the distance from the Proposed Development to the SAC, the zones of influence for the Celtic Sea Array and Proposed Development do not overlap in a manner that intersects with the boundaries of the SAC. Whilst it is acknowledged that animals from the site could be present within the Proposed Development the potential for effects is covered by the assessment above. It is concluded that there is no potential for cumulative effects on the Slaney River SAC from the combined effects of the Celtic Sea Array and Proposed Development.

5.3.4 What measures can be implemented to mitigate the significance of the likely adverse effects into insignificance?

Mitigation measures listed in Section 5.3.3 above will be directly applicable to this site and will be implemented. It has not been repeated here but in summary it includes:

- Avoid the need for detonation completely by following steps outlined in Table 2-2.
- Follow (2014) Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (Table 2-2).
- In consultation with DHPLG – Foreshore Unit and NPWS, acoustic deterrent devices (ADDs) will be selected and deployed for 20 to 60 minutes prior to UXO detonation depending on UXO charge size.
- Use of a PAM system in conjunction with ADDs – this would enable the MMO to monitor the presence or absence of pinniped within the zone of influence prior to detonating any UXO.
- If the UXO identified is greater than 10kg than a soft-start procedure will also be used in combination with the ADDs.

5.3.5 Conclusion

It is possible that harbour seal from this site could be located in the water and zone of influence at the time of UXO detonation. If harbour seal are killed or injured, this could adversely affect the population of the site. Given the uncertainties in determining the number of harbour seal which could be effected, if UXO is required measures will be implemented in line with Industry Best Practice for UXO detonation. Implementation will reduce the significance of the effect to a level whereby the conservation objectives of the SAC will not be adversely affected.

No other project has been identified in the region, that have the potential to interact with the Proposed Development in a manner that could cause a cumulative effect to grey seal within the SAC. The assessment concluded that there will be no potential for cumulative effects.

In light of this, it is concluded that the Proposed Development will not have an adverse effect on the integrity of the Slaney River Valley SAC either alone or in combination with other plans or projects.

Conclusion - No adverse effect on integrity of site, either alone or in combination with other plans or projects.

6. Summary

The Proposed Development has been subject to the AA process due to its location within the Hook Head SAC (site code: IE0000764) and the River Barrow and River Nore SAC (site code: IE0002162). It consists of the following features:

- Two high voltage direct current (HVDC) electricity power cables;
- A smaller fibre-optic cable for control and communication purposes;
- All associated works required to install, test, commission and complete the aforementioned cables; and
- All associated works required to operate, maintain, repair and decommission the aforementioned cables, including five repair events over the 40 year lifetime of Greenlink.

A detailed screening assessment has been conducted on the Proposed Development which concluded that it likely significant effects cannot be ruled out on the Qualifying Interests and conservation objectives of three sites:

- Hook Head SAC (site code: IE0000764) – Qualifying Interest Reef
- Hook Head SAC (site code: IE0000764) – Qualifying Interest Shallow inlets and bays
- Saltee Islands SAC (site code: IE0000707) – Qualifying Interest Grey Seal
- Slaney River Valley SAC (side code: IE0000781) – Qualifying Interest Harbour Seal

The assessment concluded that there was for a potential for cumulative effects between the Proposed Development and the Celtic Sea Array survey but effects would not be significant.

Further to screening, a Natura Impact Statement has been provided and concludes:

- Effects on the Hook Head SAC Qualifying Interest Reef from cable trenching and external cable protection will be avoided through the implementation of exclusion zones.
- Effects on the Hook Head SAC Qualifying Interest Shallow Inlets and Bays from external cable protection (if required) are negligible and will not adversely affect the integrity of the site. However, the significance of effects can be reduced further through careful selection of the HDD exits by the Installation Contractor. If the external cable protection is used, then as good practice the colonisation of the external cable protection will be monitored to inform the scientific evidence base and future development applications across maritime industries.
- Significant effects on the Saltee Island SAC and Slaney River Valley SAC Qualifying Interests grey seal and harbour seal, from the detonation of UXO (if required) will be reduced to levels whereby the integrity of the site is not adversely effected, by the implementation of Industry Best Practice mitigation i.e. the use of acoustic deterrent devices and passive acoustic monitoring.

It is the view of the authors of this NIS (Intertek Energy & Water Consultancy Services) that, following the implementation of the mitigation measures prescribed in the NIS, **the Proposed Development will not, by itself or in combination with other plans or projects, have an adverse effect on the integrity of any Natura 2000 sites** and there is no reasonable scientific doubt as to that conclusion.

REFERENCES

1 1st Line Defence (2018). Detailed Unexploded Ordnance Risk Assessment Greenlink. Report Reference DA2985. Dated 14 February 2018

2 BEIS (2018). Offshore Oil & Gas Licensing 30th Seaward Round. Habitat Regulations Assessment. Draft Appropriate Assessment: Southern North Sea. February 2018. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681627/30th_Round_Draft_AA_-_Southern_North_Sea_Blocks.pdf (Accessed March 2019)

3 BERR (2008). Department for Business Enterprise & Regulatory Reform. Review of cabling techniques and environmental effects applicable to the offshore wind farm industry. Technical Report. January 2008. In association with Defra.

4 Brasseur, S. and Reijnders, P. (1994). Involved van diverse verstoringsbronnen op het gedrag en habitatgebruik van gewone zeehonden: consequenties voor de inrichting van bet gebied. - IBN-Rapp. 113, 62 pp.

5 Continental Shelf Associated Inc 2004. Explosive removal of offshore structures - information synthesis report. U.S. Department of the Interior Minerals Management Service. Gulf of Mexico OCS Region New Orleans, LA. OCS Study MMS 2003-070. 181pp.

6 DAHG (2012). Marine Natura Impact Statements In Irish Special Areas of Conservation. Prepared by the National Parks & Wildlife Service of the Department of Arts, Heritage & the Gaeltacht

7 DAHG (2014). Guidance to manage the risk to marine mammals from man-made sound sources in Irish Waters. [online] Available at: https://www.npws.ie/sites/default/files/general/Underwater%20sound%20guidance_Jan%202014.pdf (Accessed January 2019)

8 DCAAE (2019). Climate Action Plan. [online] Available at: https://www.dccae.gov.ie/documents/Climate%20Action%20Plan%202019.pdf (Accessed June 2019)

9 DEHLG (2010). Appropriate Assessment of Plans and Projects in Ireland. [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2009_AA_Guidance.pdf (Accessed May 2019)

10 Delft (2000). Attachment E.1 (vii) Extracts from Environmental Impact of Dredging and Spoil Dumping, Delft H3544 Report, September 2000. In: Port of Waterford Company Foreshore Licence application for Maintenance Dredging FS005701. [online] Available at: https://www.housing.gov.ie/sites/default/files/migrated-files/en/Foreshore/ApplicationsandDeterminations/PortofWaterfordCompany/ApplicationDetails/FileDownLoad%

11 Department of Energy and Climate Change (DECC) (2016). Offshore Energy Strategic Environmental Assessment. Department of Energy and Climate Change. March 2016.

12 Dixon.Brosnan (2019). Ecological Assessment of estuarine habitats at Campile estuary and terrestrial ecology in proximity to Baginbun Beach for a proposed electricity

interconnector between Ireland and Wales. Revision 1. 12 April 2019.

13 European Commission (2001). Assessment of plans and projects significantly affecting Natura 2000 sites [online] Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf (Accessed May 2019)

14 European Commission (2007). Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC [online] Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/guidance_art6_4_en.pdf (Accessed May 2019)

15 European Commission (2013). Interpretation Manual of the European Union Habitats. Available at: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf (Accessed April 2019)

16 European Commission (2018a). Commission notice "Managing Natura 2000 sites The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC". Brussels, 21.11.2018 C(2018) 7621 final.

17 European Commission (2018b). Guidance on Energy Transmission Infrastructure and EU nature legislation. [Online] Available at: http://ec.europa.eu/environment/nature/natura2000/management/docs/Energy%20guidance%20and%20EU%20Nature%20legislation.pdf [Accessed 31/05/2018]

18 Hammond, P,S., Lacey, A., Gilles, S., Viquerat, P., Börjesson, H., Herr, K., Macleod, V., Ridoux, M.B., Santos, M., Scheidat, J., Teilmann, J., Vingada, N, Øien (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. [Online] Available at: https://synergy.st-andrews.ac.uk/scans3/files/2017/04/SCANS-III-design-based-estimates-2017-04-28-final.pdf (Accessed August 2018).

19 Intertek EWCS (2019). Greenlink Interconnector Limited - Marine Technical Appendix C – Underwater Noise Modelling.

20 Irish Whale and Dolphin Group (IWDG) (2019). Sightings browser. [online] Available at: http://www.iwdg.ie/ (Accessed April 2019)

21 JNCC (2017). Joint SNCB Interim Displacement Advice Note (2017). [online] Available at: http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf (Accessed January 2019)

22 JNCC (2019a) Pembrokeshire Marine/ Sir Benfro Forol. [online] Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0013116 [Accessed 22/02/2019]JNCC (2019b) Bristol Channel Approaches / Dynesfeydd Môr Hafren, [online] Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030396 (accessed February 2019)

23 JNCC (2019c) West Wales Marine/Gorllewin Cymru Forol, [online] Available at: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030397 (Accessed February 2019)

24 JNCC (2019d) North Anglesey Marine / Gogledd Môn Forol, [online] Available at: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030398 (Accessed February 2019)

25 JNCC (2019e) North Channel, [online] Available at: http://jncc.defra.gov.uk/ProtectedSites/SA

Cselection/sac.asp?EUCode=UK0030399 (Accessed February 2019)

26 JNCC (2019f). Cardigan Bay/ Bae Ceredigion. [online] Available at: http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0012712 (Accessed February 2019)

27 JNCC (2019g). Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau. [online] Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0013117 (Accessed February 2019)

28 JNCC (2019h). Large Shallow Inlets and Bays. [online] Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H1160 (Accessed April 2019)

29 Keevin, T.M. and Hempen G.L. (1997). The environmental effects of underwater explosions with methods to mitigate impacts

30 Langhamer, O (2012). Artificial reef effect in relation to offshore renewable energy conversion. State of the art. Scientific word journal.

31 Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M. and Scheidat. (2011) Short term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6.

32 Maitland P, S (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough

33 Marine Institute (2015) Ireland's Marine Atlas. Marine Institute

34 Marine Space (2018) Greenlink Interconnector Cable Landfall Locations (Wales and Ireland) - Intertidal Walkover Survey Report 2018.

35 MarLIN (2019). Species and habitat Sensitivity Assessment. [online] Available at: https://www.marlin.ac.uk (Accessed April 2019)

36 McGarry, T., Boisseau, O., Stephenson, S., Compton, R. (2017). Understanding the Effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale (Balaenoptera acutorostrata), a Low Frequency Cetacean. ORJIP Project 4, Phase 2. RPS Report EOR0692. Prepared on behalf of The Carbon Trust. November 2017.

37 MMT (2019a) Geophysical Field Report. Greenlink Ireland Wales Interconnector Offshore Surveys.

38 MMT (2019b). Environmental Field Report. Greenlink Ireland Wales Interconnector Offshore Surveys.

39 National Marine Fisheries Service (NMFS) (2018). 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

40 National Research Council (2003). Ocean noise and marine mammals. National Academies Press (US).

41 Natura 2000 (2018) Hook Head SAC Site code: IE0000764. Natura 2000 – Standard data form.

42 Fletcher, S., Saunders, J., Herbert, R., Roberts, C. & Dawson, K. 2012. Description of the ecosystem services provided by broad-

scale habitats and features of conservation importance that are likely to be protected by Marine Protected Areas in the Marine Conservation Zone Project area. Natural England Commissioned Reports, Number 088Nedwell, J., Mason, T., Barham, R and Cheesman, S (2012). Assessing the environmental impact of underwater noise during offshore windfarm construction and operation. Proceedings of Acoustics 2012 – Fremantle. 21-23 November 2012, Fremantle, Australia [online] Available at: https://www.acoustics.asn.au/conference_proceedings/AAS2012/papers/p116.pdf (Accessed April 2019)

43 Nedwell, J.R., Parvin, S.J., Edwards, B., Workman, R., Brooker, A.G. and Kynoch, J.E. (2007). Measurement and interpretation of underwater noise during construction and operation of offshore wind farms in UK water.

44 Nord Stream (2014) Results of Environmental and Socio-Economic Monitoring 2014. August 2015 [Online] Available at: https://www.nord-stream.com/press-info/library/?pk=250 (Accessed April 2019)

45 NPWS (2011a). River Barrow and River Nore SAC (site code: 2162) Conservation objectives supporting document – coastal habitats. Version 1. March 2011 [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/002162_Barrow%20Nore%20SAC%20Coastal%20Supporting%20Doc_V1.pdf (Accessed April 2019)

46 NPWS (2011b). Saltee Islands SAC 000707, Saltee Islands SPA 004002 Conservation Objectives. Version 1.0. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO004002.pdf (Accessed February 2019)

47 NPWS (2011c) Hook Head SAC 000764, Conservation objectives supporting document marine habitats [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/000764_Hook%20Head%20SAC%20Marine%20Supporting_Doc_V1.pdf (Accessed May 2019)

48 NPWS (2011d) Saltee Islands SAC (site code 0707) Conservaiton objectives supporting document – marine habitats and species. Version 1 (July 2011) [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/000707_Saltee%20Islands%20SAC%20Marine%20Supporting_Doc_V1.pdf (Accessed May 2019)

49 NPWS (2012) Saltee Islands SPA 004002. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004002.pdf (Accessed February 2019)

50 NPWS (2012) Marine Natura Impact Statements in Irish Special Areas of Conservation. A working document. April 2012

51 NPWS (2013b) Site Synopsis, Lower River Suir SAC 00213. [online] Available from https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002137.pdf (Accessed February 2019)

52 NPWS (2014a) Site Synopsis, KEERAGH ISLANDS SPA 004118. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004118.pdf (Accessed February 2019)

53 NPWS (2014c) Site Synopsis, BALLYTEIGE BURROW SPA 004020. [online] Available at: https://www.npws.ie/sites/default/files/pr

otected-sites/synopsis/SY004020.pdf (Accessed February 2019)

54 NPWS (2014c) Site Synopsis, Bannow Bay SPA 004033. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004033.pdf (Accessed February 2019)

55 NPWS (2014d) Site Synopsis, Hook Head SAC 000764. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY000764.pdf (Accessed February 2019)

56 NPWS (2015) Site Synopsis, Slaney River Valley SAC 000781. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY000781.pdf (Accessed February 2019)

57 NPWS (2017) Saltee Island SAC. Standard data form. National Parks and Wildlife Service. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/natura2000/NF000707.pdf (Accessed February 2019)

58 OSPAR Commission (2011). Intersessional Correspondence Group on Cumulative Effects. Amended 25th March 2011. Available at: http://jncc.defra.gov.uk/PDF/20110328_ICG-C_Pressures_list_v4.pdf (Accessed April 2019)

59 OSPAR Convention (2012). Guidelines on Best Environmental Practice (BEP) in Cable Laying and Operation. Agreement 2012-2. Source: OSPAR 12/22/1, Annex 14. [online] Available at: https://www.gc.noaa.gov/documents/2017/12-02e_agreement_cables_guidelines.pdf (Accessed March 2019)

60 Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., Ellison, W. T., Gentry, R. L., Halvorsen, M. B., Løkkebog, S., Rogers, P. H., Southall, B. L., Zeddies, D. G., and Tavolga, W. N. (2014). Sound Exposure Guidelines for Fishes and Sea Turles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

61 Popper, E.N. and Hastings, M.C. (2009). The effects of human-generated sound on fish. Integrative Zoology. Volume 4. Pg 43-52.

62 Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). Atlas of Cetacean distribution in north-west European waters. Joint Nature Conservation Committee, Peterborough, UK.

63 Richardson, W.J., Greene, C.R. Jr., Malme, C.I., and Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, San Diego, CA, USA.576p.

64 Russell, D.J.F., Jones, E.L and Morris, C.D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25.

65 Showler, D.A., Stewart, G.B., Sutherland, W.J., and Pullin, A.S. (2010). What is the impact of public access on the breeding success of ground-nesting and cliff-nesting birds? CEE review 05-010 (SR16).

66 Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr, C.R., Kastak, Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33: Number 4. [online] Available at: http://sea-inc.net/assets/pdf/mmnoise_aquaticmammals.pdf (Accessed March 2019)

67 Valente, J.J. and Fischer, R.A (2011). Reducing human disturbance to waterbird

communities near corps of engineers projects. Report reference ERDC TN-DOER-E29. [online] Available at: http://el.erdc.usace.army.mil/elpubs/pdf/doere29.pdf (Accessed February 2019)

68 von Benda-Beckmann, A.M., Aarts, G., Özkan Sertlek, H., Lucke, K., Verboom, W.C., Kastelein, R.A., Ketten, D.R., van Bemmelen, R., Lam, F.P.A., Kirkwood, R.J., and Ainslie, M.A. (2015). Assessing the Impact of Underwater Clearance of Unexploded Ordnance on Harbour Porpoises (*Phocoena phocoena*) in the Southern North Sea. Aquatic Mammals 2015, 41(4), 503-523, DOI 10.1578/AM.41.4.2015.503

Appendix A

Greenlink Marine Environmental Impact Assessment Report – Ireland, Chapter 3 Development of the Project and Alternatives

3. Development of the Project and Alternatives

This Chapter summarises the development of Greenlink, including the alternatives which have been considered and the rationale for selection of the Proposed Development. It considers technology selection; summarises the processes that were undertaken to identify an Irish connection point; and sets out the alternative landfalls and marine route options which have been considered in developing Greenlink.

The evolution of the Onshore Wales, Onshore Ireland, Marine Wales aspects of Greenlink are presented separately in the respective Environmental Statements and Environmental Impact Assessment Reports.

3.1 'Do-Nothing Option

The 'do nothing' option dictates that generation of electricity needs to be based in the country where it is used and constrains export of electricity when generation exceeds demand. One of the key actions identified in the European Commission Priority Interconnection Plan and the TEN-E regulations is to increase the transmission capacity between countries and improve security of supply.

To meet its obligations under the United Nations Framework Convention on Climate Change and the 2016 Paris Agreement, the European Union's goal is an electricity system to which renewables will contribute around half of the generation in 2030 and that will be fully decarbonised by 2050. A well connected and integrated trans-European grid is indispensable for making the energy transition a success (EC 2017).

Greenlink has been awarded Project of Common Interest (PCI) status by the European Commission, making it one of Europe's most important energy infrastructure projects and granting it the "highest national significance" possible.

The 'do nothing' option would therefore not be supported by Irish government and EU policy and would not support the European Union and Ireland's commitment to combating climate change.

3.2 Selection of Technology

Greenlink will consist of a pair of high voltage direct current (HVDC) submarine and underground onshore cables connected to an AC/DC converter station in each country. The converter station in Ireland will be connected to the Great Island substation via high voltage alternating current (HVAC) underground cables. Electricity will be able to flow in either direction between Ireland and Great Britain (GB).

Irish and GB electricity transportation grids operate as HVAC systems, in which the direction of the current changes (and then changes back) on average fifty times a second. However, an HVAC interconnector between the Irish and GB grids is not technically and economically feasible as:

- The Irish and British grids are not "synchronized", i.e. the current reversals are not happening at the same times – without this synchronization, power cannot be successfully transmitted between the grids with an HVAC interconnector; and
- The capacity of HVAC underground or subsea cables to transmit power reduces significantly with distance travelled such that an HVAC interconnector would not be an economic means to transmit power between Ireland and GB.

Therefore, a HVDC interconnector, including a converter station at each end to change the current to HVAC is the best current technology.

Transmission electricity losses emanate in the form of heat and are increased with the current flowing through the equipment. HVDC cable witness lower losses when compared to HVAC cables and therefore is a more efficient technology.

3.3 Connection Options

3.3.1 Irish and GB Transmission Networks

The importance of Greenlink, linking the Irish and GB Transmission Networks, is recognised through its PCI status which makes it one of Europe's most important energy infrastructure projects and granting it the "highest national significance" possible. The requirement and need for Greenlink has been reinforced by Ofgem (GB) and CRU (Ireland) via the completion of a Cost Benefit Analysis which demonstrates that Greenlink offers economic benefit to consumers in both jurisdictions.

3.3.2 Transmission Network Substation Connection Options

The configuration of any interconnector project is influenced by the location of the existing network infrastructure, its ability to accommodate the required connection capacity, any requirement for network reinforcements, and other factors such as environmental constraints. A review of these factors was undertaken for both the Irish and GB Transmission Networks by EirGrid and National Grid Electricity System Operator, respectively.

3.3.3 Irish Transmission Network

A review of suitable points of connection was undertaken in Ireland. Connection locations on the east of Ireland were assessed. Following a network review the most suitable location on the east of the Irish Transmission Network was found to be the Great Island Substation in County Wexford.

3.3.4 GB Transmission Network

The National Grid completed a Connections and Infrastructure Options Note process to assess potential grid connection locations within the GB Transmission Network. Connection locations to the west of the GB Transmission Network were assessed.

The Connections and Infrastructure Options Note process is a defined procedure which is used for all large electricity users and generators seeking connection to the GB electricity network. This process considers both the cost benefit of different connection options and the engineering limitations of the existing network.

Eight substations were initially considered as potential connection points. National Grid Electricity System Operator then completed a Cost Benefit Analysis for the four remaining options (Alverdiscott 400kV, Swansea North 400kV, Pembroke 400kV and Pentir 400kV). Figure 3-1 and Table 3-1 presents a figure and table included in the Connections and Infrastructure Options Note that summarises route distances between Ireland and the four options.

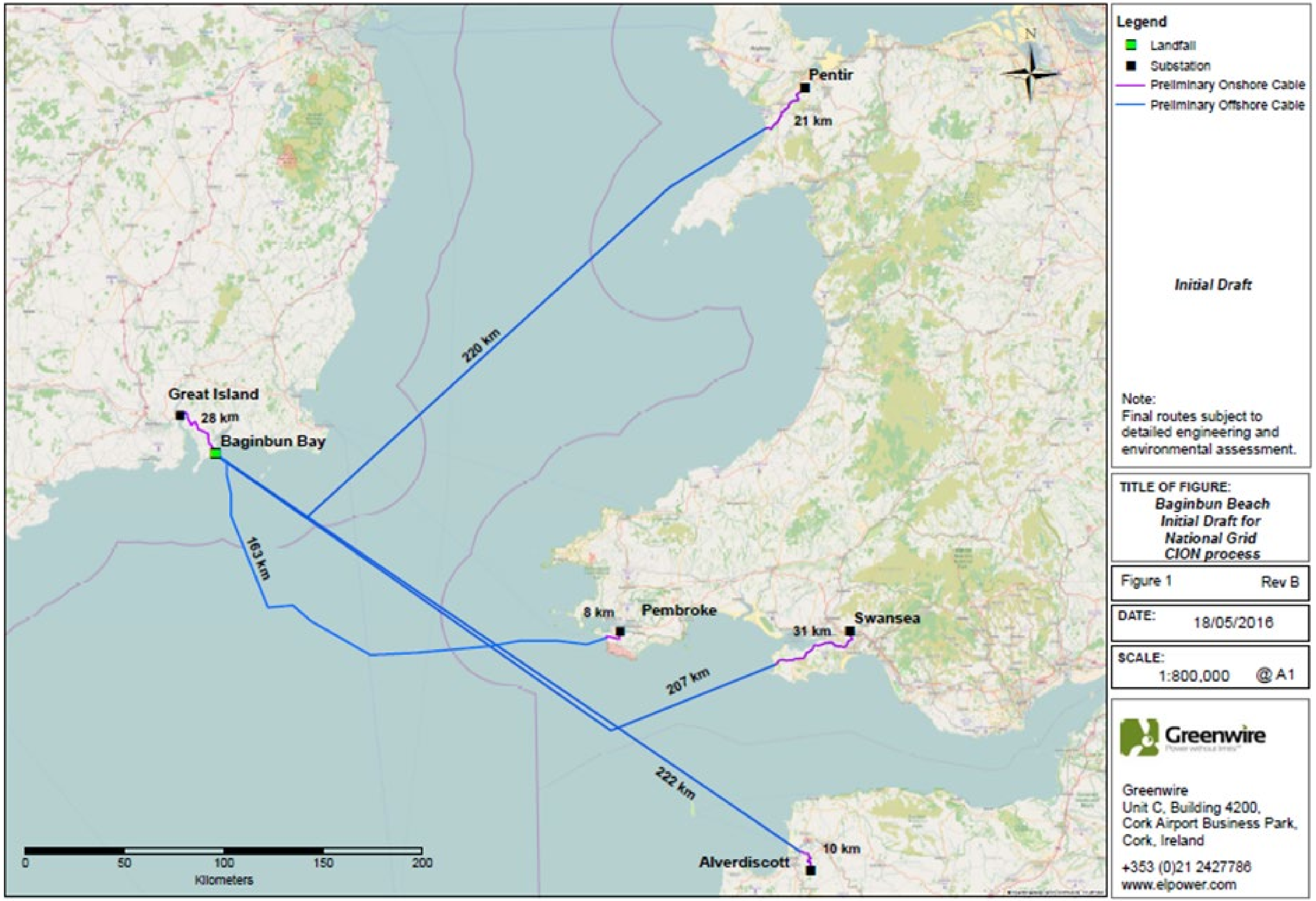
Table 3-1 Summary of project distances

	Distance (km)		
Site	Onshore	Offshore	Total Distance
Alverdiscott 400kV	38	222 (direct)	260
Pembroke 400kV	36	159 (known constraints included)	195
Swansea North 400kV	59	207 (direct)	266
Pentir 400kV	49	220 (direct)	269

Note: It was acknowledged that length of direct offshore routes is likely to increase by 10 to 20% as constraints become known and therefore costs would increase accordingly.

After completing the Connections and Infrastructure Options Note and Cost Benefit Analysis, National Grid Electricity System Operator determined the most economical connection point to be Pembroke 400kV substation, requiring only a busbar extension to provide a connection point for Greenlink. National Grid Electricity System Operator also concluded that the site facilitates the connection from other points of view (environmental, consenting etc) and as such is the preferred connection point.

Figure 3-1 Summary of project distances



3.4 Landfall Options

Following identification of Great Island substation as the connection point for Greenlink, an options appraisal study of the adjacent coastline was undertaken using a search area from approximately Brownstown Head, Co. Waterford to Bannow Beach, Co. Wexford. Ten potential landfall sites were selected based on their proximity to the Great Island substation.

The decision was taken early on to discount a route up the River Barrow estuary directly to Great Island for the following reasons:

- The River Barrow estuary adjacent to the Great Island substation forms part of the River Barrow and River Nore Special Area of Conservation (SAC). The site is important for the presence of a number of EU Habitats Directive Annex I listed habitats and well as Annex II listed species such as Freshwater Pearl Mussel, White-Clawed Crayfish, Salmon, Twaite shad, three lamprey species (sea, brook and river lamprey), the whorl snail *Vertigo moulinsiana* and otter. The River Barrow is the only site in the world for the hard water form of the Freshwater Pearl Mussel and one of only a few rivers in Ireland in which twaite shad spawn.
- Although there is a navigation channel through the estuary to the Port of Waterford in which water depths reach 10m, water depths across most of the estuary are typically 5m or less. Constraints in this area include:
  - Navigation channels, dredged channels and designated anchor zones are avoided where possible when routeing a cable due to the risk posed to the cable from dredging and accidental anchoring. Additionally, the sterilisation of a designated anchor zone and the disruption effects to commercial shipping that would be experienced during installation.
  - Long stretches of shallow water depths are technically difficult from a cable installation perspective, requiring very slow moving anchored barges. This can lead to increased levels of disruption, habitat disturbance and higher costs.

The options appraisal (desk-top study), undertaken by Intertek EWCS (2015), considered a range of environmental, technical and economic constraints to identify suitable landfall locations within the search area. It was undertaken in parallel with consideration of onshore locations for converter stations and underground and marine cable routes.

Ten potentially suitable landfall locations were identified, of which four were visited by Arup (Onshore Consultants) and eight were visited jointly by Arup and Intertek EWCS (Offshore Consultants) in 2015. This ensured all sites had been visited and assessed. Shown on Figure 3-1 (Drawing P1975-LOC-003), the ten sites were Rathmoylan Cove, Boyce's Bay, Sandeel Bay, Carnivan Bay, Baginbun Beach, Dollar Bay, Booley Bay, Newtown Beach, Bannow Beach and Cullenstown Beach.

Each landfall site was scored based on technical and environmental criteria. Criteria assessed included vessel access, beach composition, amenity impact, environmental constraints (e.g. presence of protected sites), exposure, coastal erosion, access to beach, cable engineering and protection requirements, obstructions and existing infrastructure.

After site visits, four preferred options were identified:

1. Baginbun Beach;
2. Sandeel Bay;
3. Booley Bay; and
4. Boyce's Bay.

Of these sites, landfalls 1 and 2 are on the east coast of the Hook Head Peninsula, 3 and 4 are on the west coast of the Hook Head Peninsula.

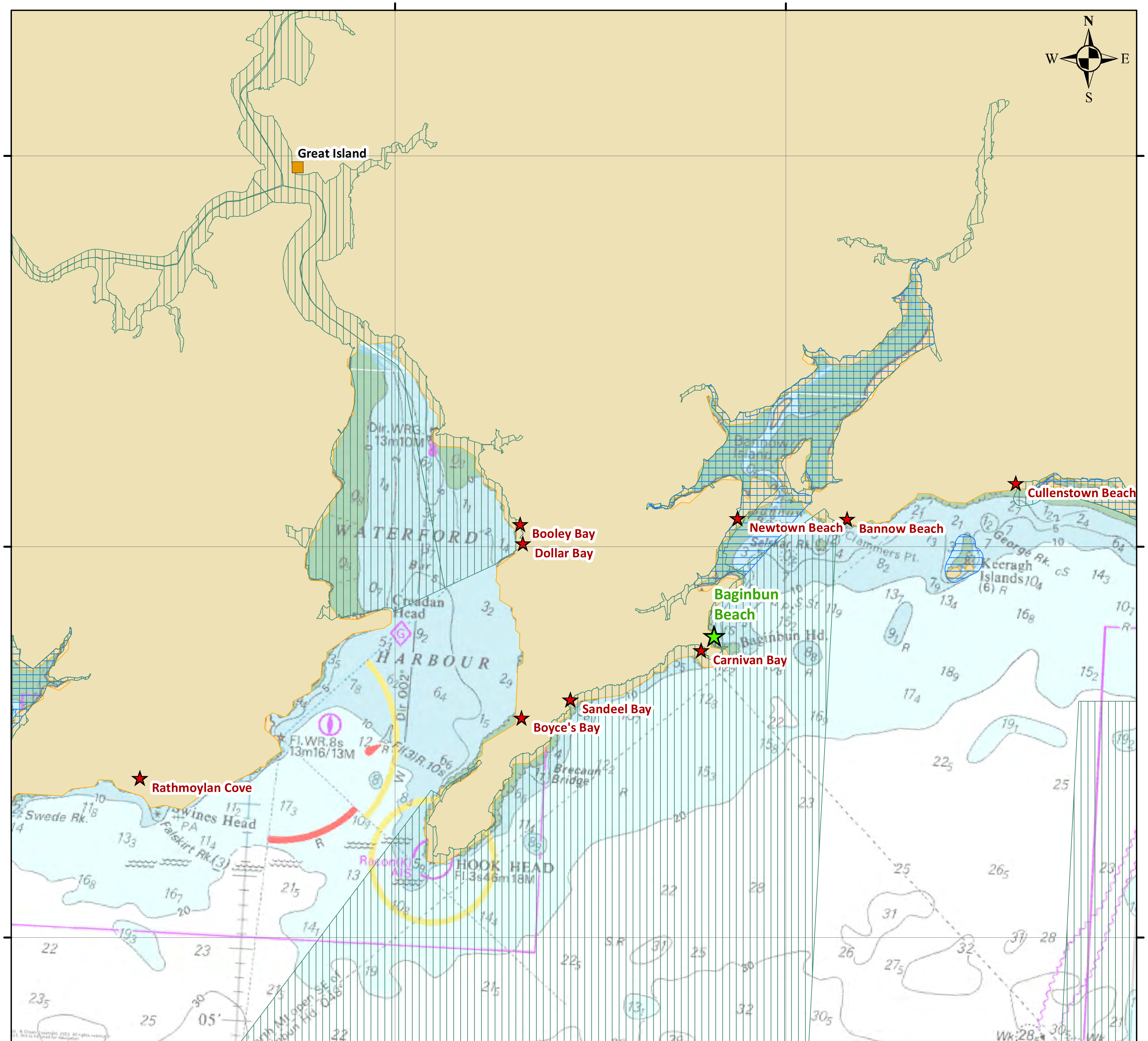
Table 3-2 provides a summary of the four options and the reason for the selection of Baginbun Beach as the preferred landfall. A report outlining the route selection process and the environmental effects considered as part of this selection process in greater detail are included at Technical Appendix L.

GREENLINK INTERCONNECTOR

ROUTE OVERVIEW

ROI Landfall Options

Drawing No: P1975-LOC-003 | **A**



Legend

- Power Station
- Landfall Selected
- Landfall Considered

Protected Sites

- SAC
- SPA

Date	Thursday, April 25, 2019 08:46:58
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	NPWS; GEBCO; MarineFind
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 1 2 3 4 km

Table 3-2 Landfall options

Name	Description	Decision
Baginbun Beach	Baginbun Beach is located to the north of Carnivan Bay on the Baginbun peninsula. It lies within the Hook Head Special Area of Conservation (SAC) but the cable would have less distance in the SAC than at alternative sites such as Sandeel Bay. The beach faces north east, has excellent access for vessels and the eastward facing aspect would protect the site from prevailing wind conditions. The gradient of the beach was flat (1.7°) and the sediment was generally uniformly distributed coarse sand with occasional whole or partial shells. Notably, there was very little man-made debris. Offshore, lobster / crab pots were observed indicating fishing activity in the area. Surrounding the beach are heavily vegetated cliffs of moderate height (< 15 m) with only minor signs of erosion on the northern side of the beach. Height and apparent stability would suggest horizontal directional drilling would be possible but would require appropriate geological assessment and survey of ground conditions for confirmation. Consultation with the Foreshore Unit indicated that the beach has high amenity value especially during summer months. The beach has historical importance as the site of an Anglo-Norman invasion in May 1170.	**Landfall Selected as Preferred Option** Selection was based on the fact that it offered the shortest overall offshore cable route length and met the technical requirements other landfalls fell short on. Selection as the preferred option was however, dependent on the results of the cable route survey. The survey needed to demonstrate that the submarine cable route could be installed without significantly affecting the conservation objectives of the Hook head SAC. A sand channel with sufficient depth to achieve cable burial has been confirmed during the cable route survey, through the SAC to Baginbun Beach (see Section 3.5.5.)
Sandeel Bay	Sandeel Bay is located to the south of the Baginbun peninsula on the east of the Hook peninsula. Lying within the Hook Head SAC, it is close to Hookless Village / Sandeel Bay Cottages, a popular holiday resort. The cliffs surrounding the beach are approximately 10 - 15 m in height with small localised areas of erosion and landslip. There is a rock outcrop to the south of the bay. The beach gradient is shallow and demonstrates large amounts of seaweed and debris. There also appears to be sediment zonation indicative of sediment sorting associated with high-energy condition.	**Landfall Discounted** Initially, the landfall was not considered a 'preferred' option as the offshore environmental constraints were considered too significant. Following consultation with the National Parks & Wildlife Service (NPWS) (09 December 2015) it was concluded that installing a cable through a SAC could potentially be possible provided that works do not adversely affect the integrity of the protected site and its conservation objectives. In the interest of achieving the most direct offshore cable route, Sandeel Bay

Name	Description	Decision
	The site would not be suitable for open-cut trenching due to the volume of rock and the seawall approaching the path. HDD may be suitable but geotechnical data assessment would be required to confirm suitability.	was reinstated as a potential landfall location, despite the relatively low score in assessment. It was subsequently de-selected when analysis of INFOMAR bathymetric data identified likely extensive reef habitat offshore, confirming any route to the landfall would likely have significant effect on the conservation objectives of the SAC.
Boyce's Bay	This landfall location lies on the west coast of the Hook Peninsula, within the Port of Waterford harbour limits. The site is located outside the Hook Head SAC, but it falls within a proposed Natural Heritage Area (NHA). The beach faces the south west making it an exposed site, given the prevailing south-westerly weather conditions. Due to the shallow waters and location of the 5 and 10 m depth contours, the types of vessel that can reach the beach may be restricted, increasing the chances of requiring anchored barges. The beach extends further north along the coastline for approximately 2 km but a rock outcrop to the north of the site prevents vehicles from accessing the additional coastline and beach. The beach itself is gently sloping with evidence of a storm berm and seaweed debris on the upper reaches of the beach. The typical slope angle was 2.4° from the cliff to the water. The beach was approximately 200m wide, with approximately 157 m of rock to the south of the beach. Fossils were observed on rock outcrops on the side of the bay. The surrounding cliffs and headland are high with one large derelict property at the top, close to the dairy farm; this is possibly a heritage site and would require confirmation prior to establishing the location for an HDD point. The surrounding cliffs are densely vegetated with grasses and scrub but there are many indicators of instability and slope movement. Portions of the cliffs were identified as suitable for HDD up to the main track, pending further geotechnical assessments and ground investigation.	**Landfall reserved as Second Preferred Option pending survey of Baginbun Beach.** Selected as an alternative for investigation should the cable route survey identify substantial issues which could result in a route to Baginbun Beach not being feasible. The Port of Waterford has expressed concerns that the proposed route to Boyce's Bay enters the shipping channel passing Hook headland. They have not granted permission for the route to extend into the central channel where there are potentially deeper Holocene sediments. Instead, their preference is for the cable to be routed as close to the headland as possible. A compromise, whereby the route follows the edge of a mapped outcrop to the east of the channel centre, was proposed. However, this area may have only a veneer of sediment overlying rock which would likely result in external rock protection (e.g. rock berm) being required. The outcropping rock is likely to be Annex I Reef (Stony Reef) habitat and although not within the Hook Head SAC forms part of the wider habitat for which the site is designated. As well as increasing installation costs installation across the outcropping rock has the potential to significantly affect a sensitive habitat.

Name	Description	Decision
		The landfall was discounted in 2018 when the cable route survey confirmed a route into Baginbun Beach was feasible.
Booley Bay	Booley Bay is approximately 5 km north of Boyce's Bay, within the Port of Waterford harbour limits. Like Boyce's Bay, the landfall faces the west and is moderately exposed to the prevailing southwesterly wind conditions. The beach is approximately 205 m wide and 113 m from the cliff to the water's edge shortly before low water. The beach is predominately flat (0.2°) with fine, water saturated sand. A storm berm was observed at the upper reaches of the beach. The surrounding headland is dominated by vegetated cliffs to the north and south, both sides demonstrated low levels of coastal erosion with minor evidence of disruption by landslides. Adjacent to the access road and track was a freshwater riverine input, surrounded by unmanaged vegetation. The river water flows directly onto the beach where the water flow is diverted along the upper reach of the beach to the southern rock outcrop where it is forced towards the sea by rocks. Options for installation would include HDD and open-cut trenching. It is likely that the flow of freshwater onto the beach would make keeping a trench open difficult and may risk exposure of the cable during adverse weather conditions.	**Landfall Discounted** Consultation with the Port of Waterford was undertaken on 09 March 2016. At the meeting the Harbour Master advised the Booley Bay landfall be dropped from further consideration. A 100m wide corridor (marked on Admiralty Chart) is dredged at Duncannon approximately 3-4 times a year, to stop the shipping channel from silting up. The offshore approach to the landfall would intersect this area risking both the ports activities and the cable.

3.5 Offshore Route Selection

The development of the submarine cable route balances the need for a technically feasible and economically viable route corridor whilst limiting disturbance to people and the environment, and minimising cable length. In identifying preferred options, and determining if a route is feasible, the physical, environmental and human aspects were considered.

Route development has been an iterative process involving cycles of consultation, refinement and survey. The submarine cable route has been designed to avoid or reduce environmental effects to ALARP levels (i.e. As Low As Reasonably Practicable) while also accommodating other factors.

Three main objectives have driven route development:

- To avoid where possible, or otherwise minimise the distance through which the route crosses reef habitat within the Hook Head SAC (Proposed Development) and Pembrokeshire Marine Special Area of Conservation (SAC) (Marine Wales); and
- To minimise disruption to shipping associated with Waterford Port (Proposed Development), Milford Haven (Marine Wales), and offshore traffic separation schemes (Marine Wales); and
- To avoid where possible, or otherwise minimise the distance through which the route crosses the Castlemartin Firing Range (Marine Wales).

The stages of the process to define the Greenlink route are described in detail below, but can be summarised as follows:

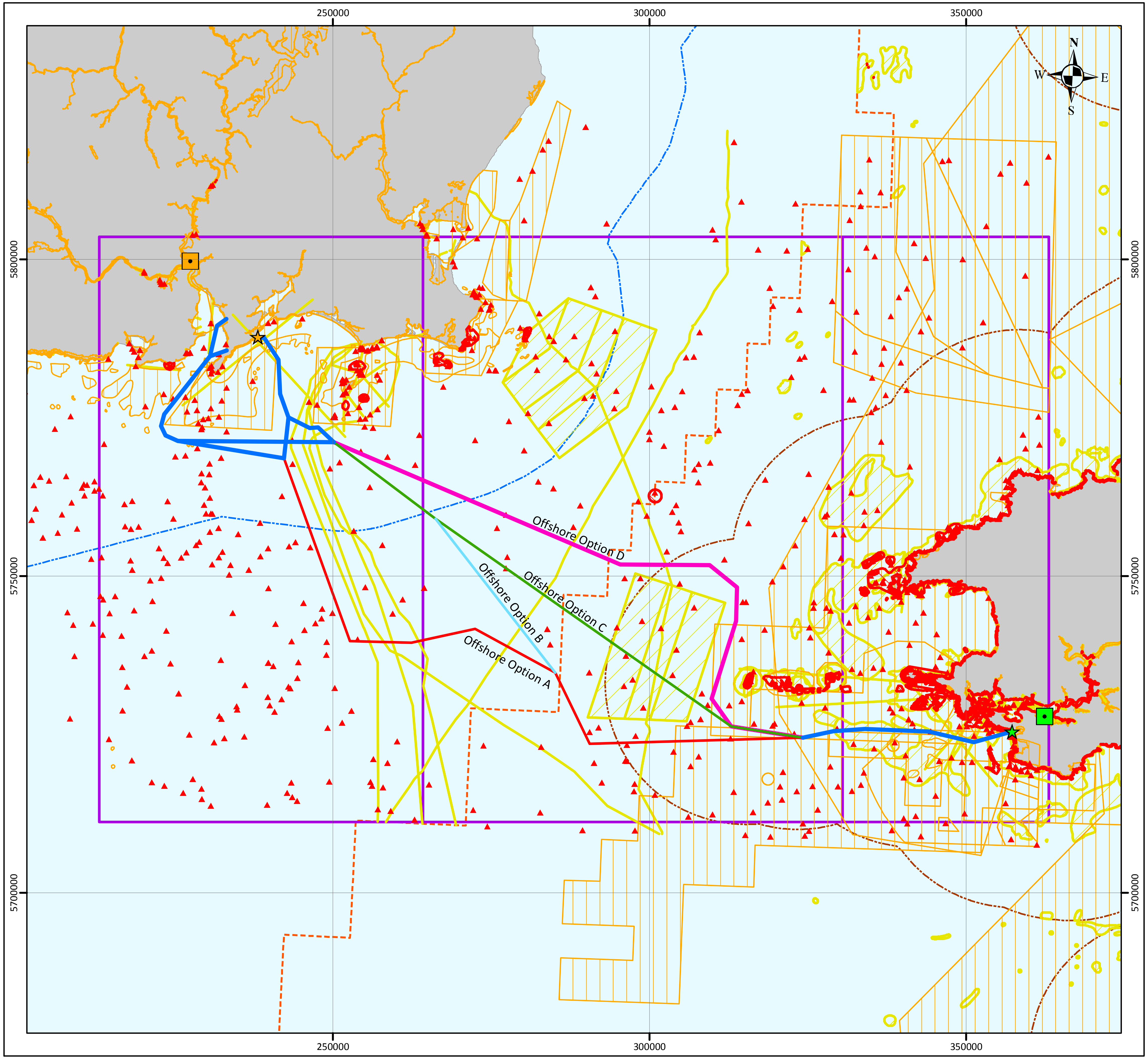
2015	Desk-top study (Intertek 2015) develops four offshore routes (Options A, B, C and D) between Freshwater West, Wales and three short-listed landfalls (Boyce's Bay, Booley Bay and Baginbun Beach) in Ireland.
Dec 2015	Consultation with Irish National Parks & Wildlife Service (NPWS) concludes in re-instatement of fourth Irish landfall; Sandeel Bay.
Dec 2015	GIL and Intertek routeing workshop discounts Options B, C and D but introduces Options E and F.
Feb - Aug 2018	Re-examination of routes ahead of cable route survey. Consultation and new data leads to refinement and new route option development. Option E and Option F re-named to Route A and Option C respectively. Routes B and E (Wales Marine) and Option D (Irish Marine) developed.
Sep - Dec 2018	Reconnaissance survey of Route A and Route E in Welsh waters. Consultation with NRW and further survey leads to final route being defined.

3.5.1 Desk-top study 2015

GIL commissioned Intertek EWCS to undertake a desktop study (Intertek EWCS 2015) to identify feasible submarine cable corridors between three short-listed landfalls in Ireland (Boyce's Bay, Booley Bay and Baginbun Beach) and the recommended landfall at Freshwater West, Wales for further investigation.

Constraints within the study area were identified and categorised as major, moderate, minor or no constraint, according to the likely impact on cable installation. The constraint categories were mapped and routes were designed to take cognisance of the constraints and their categorisation.

The outcome was four offshore routes with options to connect to each of the landfalls in Ireland; Figure 3-3 (Drawing P1975-LOC-005). These were identified as Options A to D; with the shortest route Option A being 145km and the longest Option D being 186km. Options B, C and D all crossed a large area of sand waves. These sediment features can complicate installation activities and notably, existing telecommunication cables have been routed around these sand waves.



GREENLINK INTERCONNECTOR

ROUTE OVERVIEW
Preliminary Route Options

Drawing No: P1975-LOC-005 | **A**

Legend

Substation
- Pembroke Power Station
- Great Island

Landfall
- Freshwater West
- Baginbun Beach

Preliminary Route
- Nearshore Route Options (Dependant on Final Landfall)
- Offshore Option A
- Offshore Option B
- Offshore Option C
- Offshore Option D
- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line
- Study Area

Challenging Constraints
- Minor
- SAC ROI
- Major

NOTE: Not to be used for Navigation

Date	Friday, April 12, 2019 15:39:30
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; CDA; JNCC; NPWS; GEBCO; UKHO; Oceanwise; Greenlink;
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-005.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 5 10 15 20 km

3.5.2 NPWS consultation December 2015

On 09 December 2015 the National Parks & Wildlife Service (NPWS) was consulted regarding the Irish landfalls, resulting in the re-instatement of a fourth landfall site; Sandeel Bay.

3.5.3 Route workshop December 2015

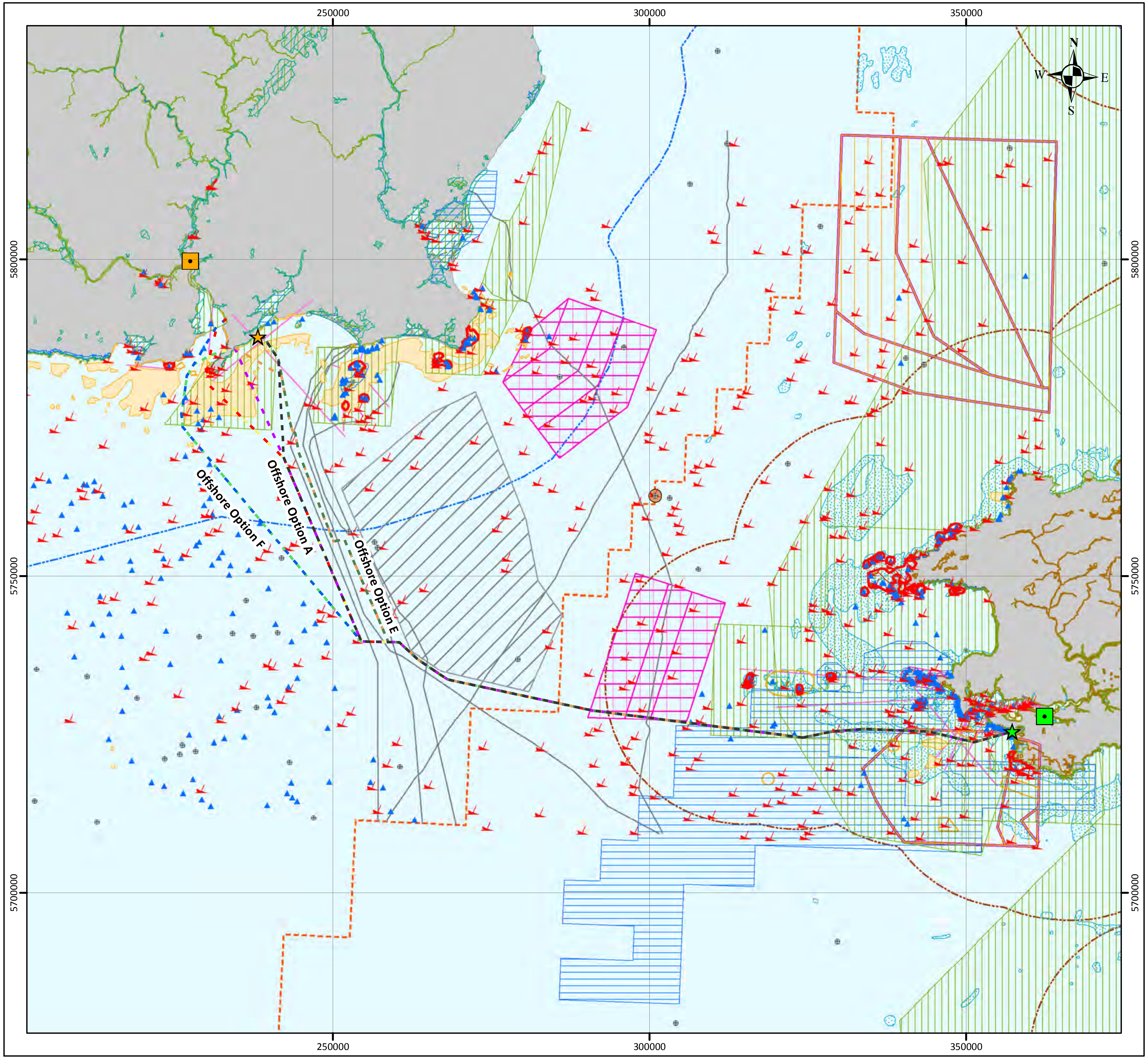
GIL and Intertek EWCS conducted a routeing workshop on 10 December 2015. At this workshop preliminary research into the area of sand waves was presented, concluding that the heights of waves are between 10 – 15 m with slope angles in excess of 10°. The sand waves by their nature are likely to be mobile, however there is little confirmation of the rate of this mobility and it would require several bathymetric campaigns at different times to determine the mobility. A decision was made to discount Options B, C and D from further investigation.

An alternative Option E was introduced, during the workshop, to alter the approach to the cable-crossings. Option E sought to conduct the cable-crossings in a 'stepped' approach and thus shorten the route. The result was a 2km reduction in cable length when approaching the Baginbun Beach landfall.

Refinements were also made to Option A & E in the Irish nearshore region owing to additional bathymetric and geological data being available. In addition, an Option F was developed as an alternative shorter option to Option A to the landfalls on the west coast of the Hook Head Peninsula.

Options A, E and F as defined after the workshop are shown in Figure 3-4 (Drawing P1975-LOC-006).

Intertek EWCS (2016b) subsequently concluded that the 'preferred route' for survey depended on the Irish landfall chosen, but based on the shortest, least constrained route, Option E was currently the preferred route.



GREENLINK INTERCONNECTOR

ROUTE OVERVIEW
Options A, E, and F as defined in December 2015

Drawing No: P1975-LOC-006 | **A**

Legend

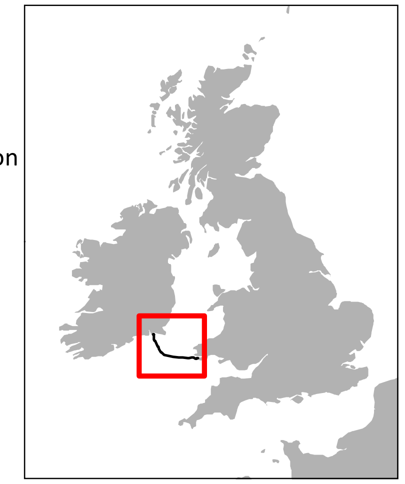
Substation
- Pembroke Power Station
- Great Island

Landfall
- Freshwater West
- Baginbun Beach
- Option A to Baginbun
- Option A to Booley Bay
- Option A to Boyces Bay
- Option A to Sandeel Bay
- Option E to Baginbun
- Option E to Sandeel Bay
- Option F to Booley Bay
- Option F to Boyces Bay
- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line

Constraints
- Well
- Obstruction
- Wreck
- Offshore Installation
- Navigation Line
- Traffic Separation Scheme
- Military Practice Area
- Dumping Ground
- Foul Ground
- Rock
- Sandwaves

Environmental Sites
- SAC
- SPA
- NHA
- pNHA
- SSSI

Rocky or Biogenic Reef Confidence
- High
- Potential



Date	Thursday, April 25, 2019 08:21:34
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; CDA; NPWS; JNCC; NRW; GEBCO; UKHO Oceanwise; Greenlink
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-006.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 5 10 15 20 km

3.5.4 February to August 2018

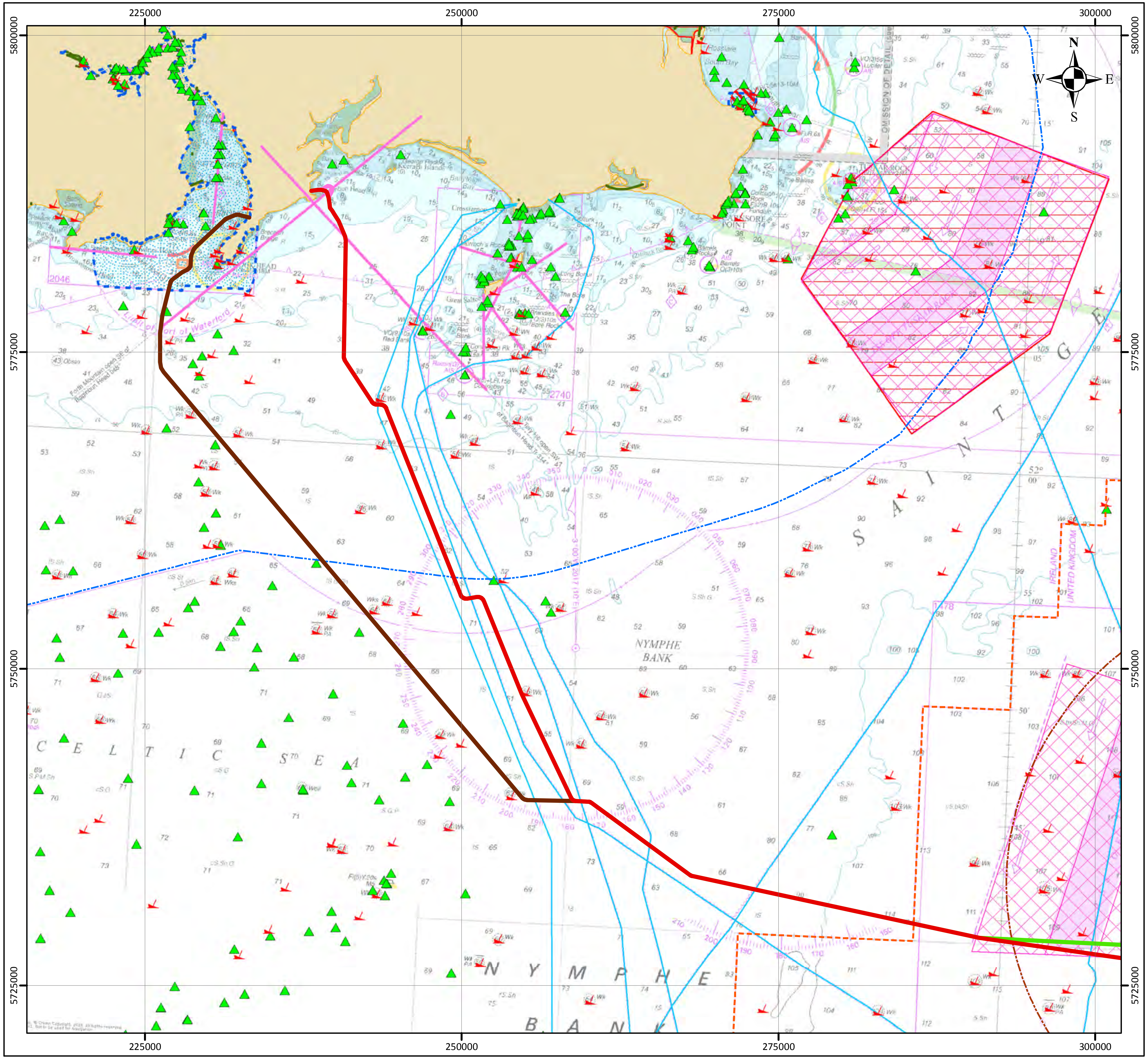
Ahead of the cable route survey Option E (to Baginbun Beach) and Option F (to Boyce's Bay) were re-examined in light of new data and consultation undertaken with Port of Waterford Company, and in Wales, Natural Resources Wales, Castlemartin Firing Range and Milford Haven Port Authority.

These two routes were renamed to become Route A (to Baginbun Beach) and Option C (to Boyce's Bay) respectively in the subsequent route development work as reported in Intertek EWCS (2018b).

3.5.4.1 Ireland

Consultation with the Port of Waterford Company (identified serious reservations with the Irish landfalls on the western side of the Hook Head Peninsula (Boyce's Bay and Booley Bay). Port of Waterford Company requested that any route within the estuary should avoid the main navigation channel and follow or be as close to as possible the outcropping rock on the eastern coastline. This constraint combined with the environmental sensitivities of the River Barrow estuary (i.e. reef habitat and important twaite shad spawning habitat), led to the recommendation that Baginbun Beach should be considered the preferred landfall for cable route survey. This therefore identified that Route A would be the 'preferred route' for survey, but with Option C to Boyce's Bay retained in case survey of Route A proved unfeasible ground conditions were present (Figure 3-5, Drawing P1975-LOC-007).

On the approach to Baginbun Beach, Option D was developed as an option to Route A to avoid an area of outcropping rock identified on bathymetric survey data obtained from INFOMAR; shown on Figure 3-6 (Drawing P1975-BATH-005).



GREENLINK INTERCONNECTOR
ROUTE OVERVIEW
Pre-Survey Irish Route Development

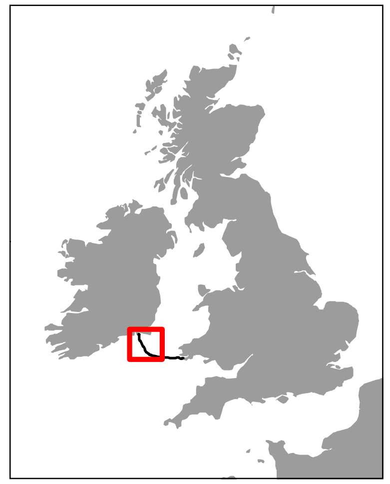
Drawing No: P1975-LOC-007	A

Legend

Greenlink Interconnector Proposed Routes
- Route A Rev1
- Route E Rev1
- Option C Rev0
- Option D Rev1
- ROI 12nm Territorial Sea Limit
- UK 12nm Territorial Sea Limit
- Median Line

Marine Structure or Obstruction
- Obstruction
- Wreck
- Cable
- Shoreline Construction

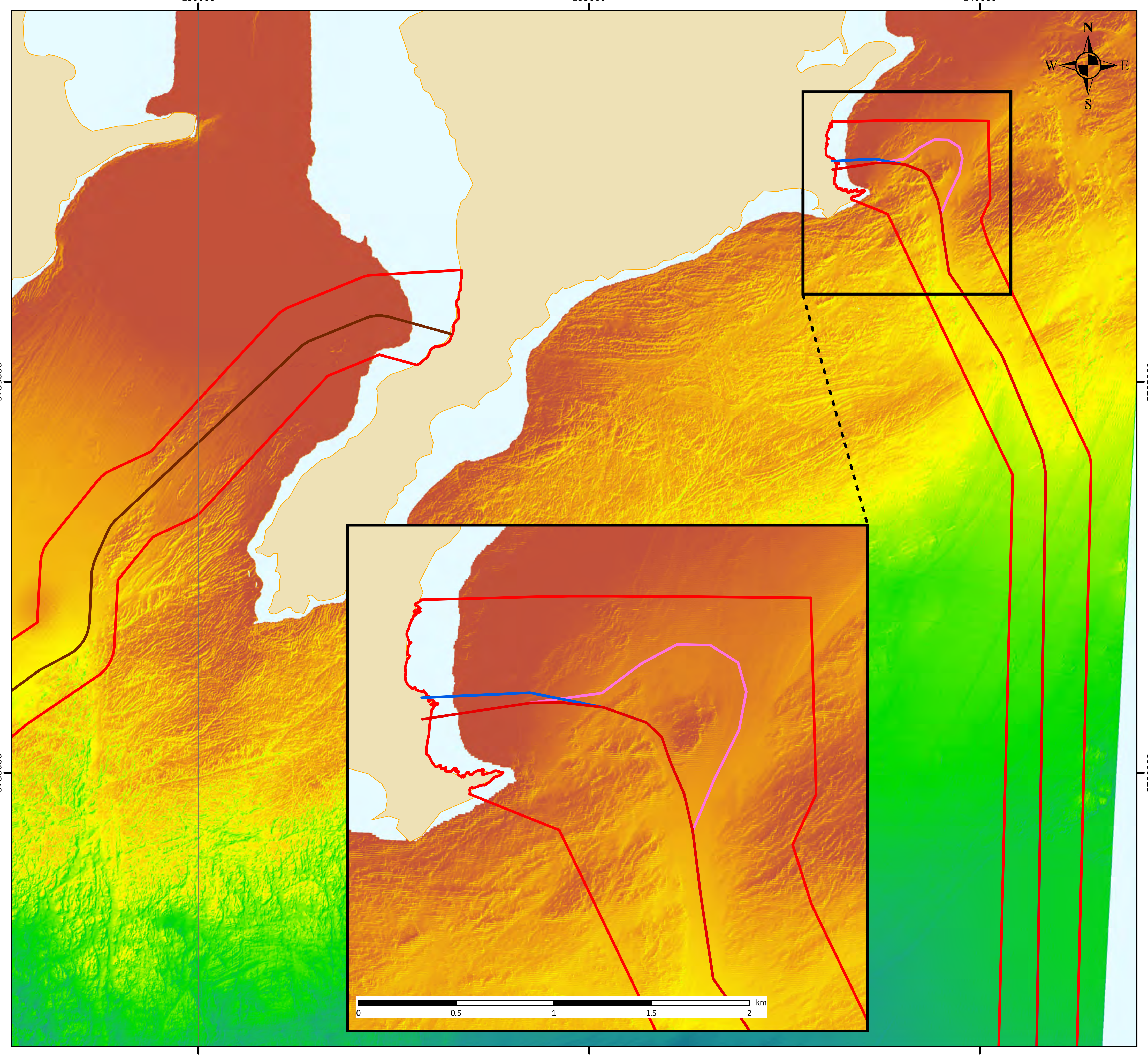
Marine Use Areas
- Navigatuion Line
- Harbour Area (Administrative)
- Traffic Separation Zone
- Dumping Ground
- Caution Area
- Restricted Area



Date	Tuesday, April 9, 2019 11:28:15
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	UKHO; DCCAE; CDA; KISORCA; GEBCO MarineFind; Oceanwise; Greenlink
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-007.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Greenlink
Co-financed by the European Union
Connecting Europe Facility
intertek

0 2.5 5 7.5 10 km



GREENLINK INTERCONNECTOR
BATHYMETRY
Nearshore ROI Waters

Drawing No: P1975-BATH-005 | **A**

Legend

Greenlink Interconnector Proposed Routes
- Route A Rev1
- Route B Rev0
- Option C Rev0
- Option D Rev1
- Proposed Development

INFOMAR Bathymetry

Bathymetry (below LAT)
-4m
44m

Date	Monday, April 8, 2019 09:32:29
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	UKHO; OSI; INFOMAR; Greenlink
File Reference	J:\P1975\Mxd\04_BATH\ P1975-BATH-005.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km

3.5.4.2 Wales

Further route development occurred to reduce the distance of the route either in protected sites or reduce distance through sensitive habitat features as follows:

Route A

- Minor route amendments were made to move the route further south, reducing the distance the route crossed the Skomer, Skokholm and the Seas off Pembrokeshire Special Protection Area (SPA). Routeing is constrained by the location of a disused explosive dumping ground in this area.
- Where appropriate, alterations were made to minimise the length of the route across potential reef features, a designating feature of the Pembrokeshire Marine SAC.
- The route was optimised to consider new information obtained on wrecks and obstructions.
- Nearshore route adjustments were made using SEACAMS bathymetric data provided by Bangor University. A channel infilled with sediment was identified within the outcropping rock. The routes were revised to follow this channel.
- The amendment resulted in the route going further into the Castlemartin Firing range. Consultation with the MoD confirmed that this was feasible.

Route B

- An alternative to Route A in Welsh waters, this route sought to reduce the distance within the Pembrokeshire Marine SAC and crossing of potential areas of bedrock reef habitat.
- This option encroaches further into the Castlemartin Firing Range; although this was confirmed as acceptable through consultation with the MoD.
- Route B was later discounted from further investigation, as although it reduced the distance through the Pembrokeshire Marine SAC it did not minimize the length of potential reef habitat crossed. Consultation with NRW confirmed that reef habitat outside the SAC should be regarded in the same manner as reef habitat within the SAC.

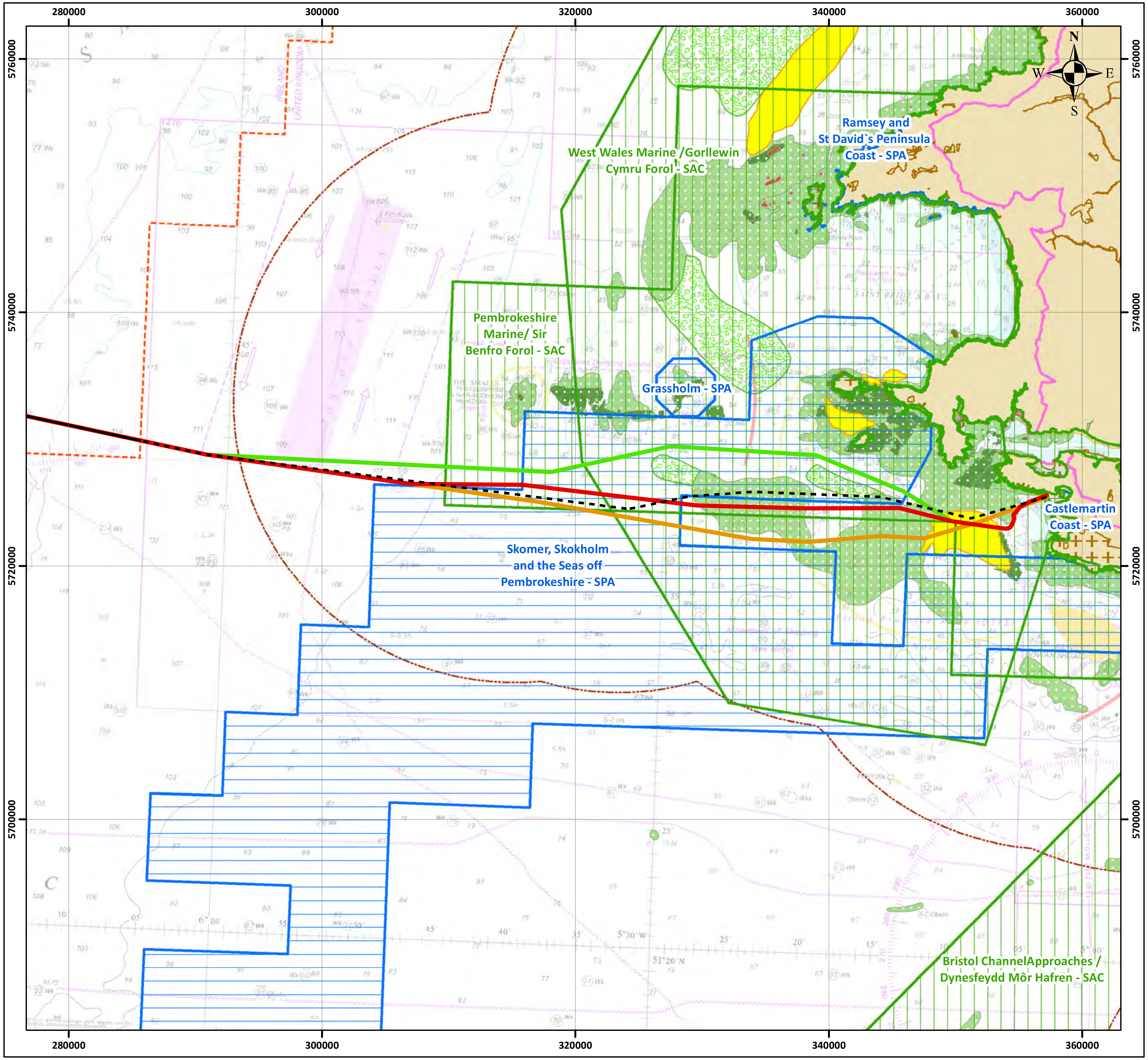
Route E

- Following consultation with NRW, it was concluded that further efforts should be made to avoid the potential areas of reef; a designating feature of the Pembrokeshire Marine SAC.
- Route E sought to avoid potential areas of reef by routeing around it to the north.
- Routeing closer to the Milford Haven harbour entrance was confirmed as possible through consultation with Milford Haven Port Authority.

Routes A, B and E are shown in Figure 3-7 (Drawing P1975-LOC-004).

Intertek EWCS (2018b) concluded the preferred option for survey was Route A, due to it being the shortest route. However, it was recommended that an initial reconnaissance survey was undertaken to assess the presence and quality of reef and / or sensitive habitats along Route A within the Pembrokeshire Marine SAC. If reef habitat was identified then investigation of Route E should be undertaken to allow comparison and selection of a route that minimizes the potential effects on the habitat.

A strategy was developed and agreed with NRW, that provided a decision making process to be followed during the survey. The objective of the strategy was to provide a framework for comparing the environmental results from Route A and Route E leading to a decision on the final route for survey. The area defined as the 'reconnaissance survey' is shown in Figure 3-8 (Drawing P1975-SURV-011).



GREENLINK INTERCONNECTOR

ROUTE OVERVIEW

UK Route Development

Drawing No: P1975-LOC-004 | **A**

Legend

- Original Proposed Route
- Route A Rev1
- Route B Rev0
- Route E Rev1

Environmental Designations

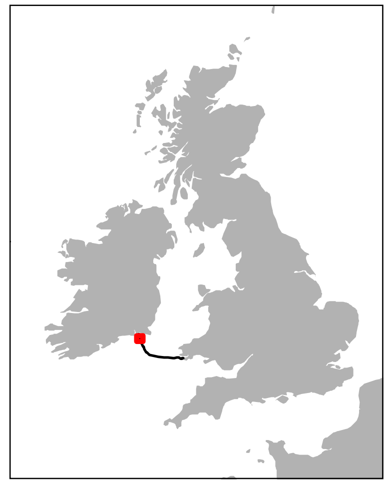
- SAC
- SPA
- SSSI
- National Park

Protected Sandbank Slightly Covered by Seawater

- Sandbank Area (High Confidence)
- Potential Sandbank

Potential Reef

- Bedrock (High Confidence)
- Bedrock (Potential)
- Stony (Potential)



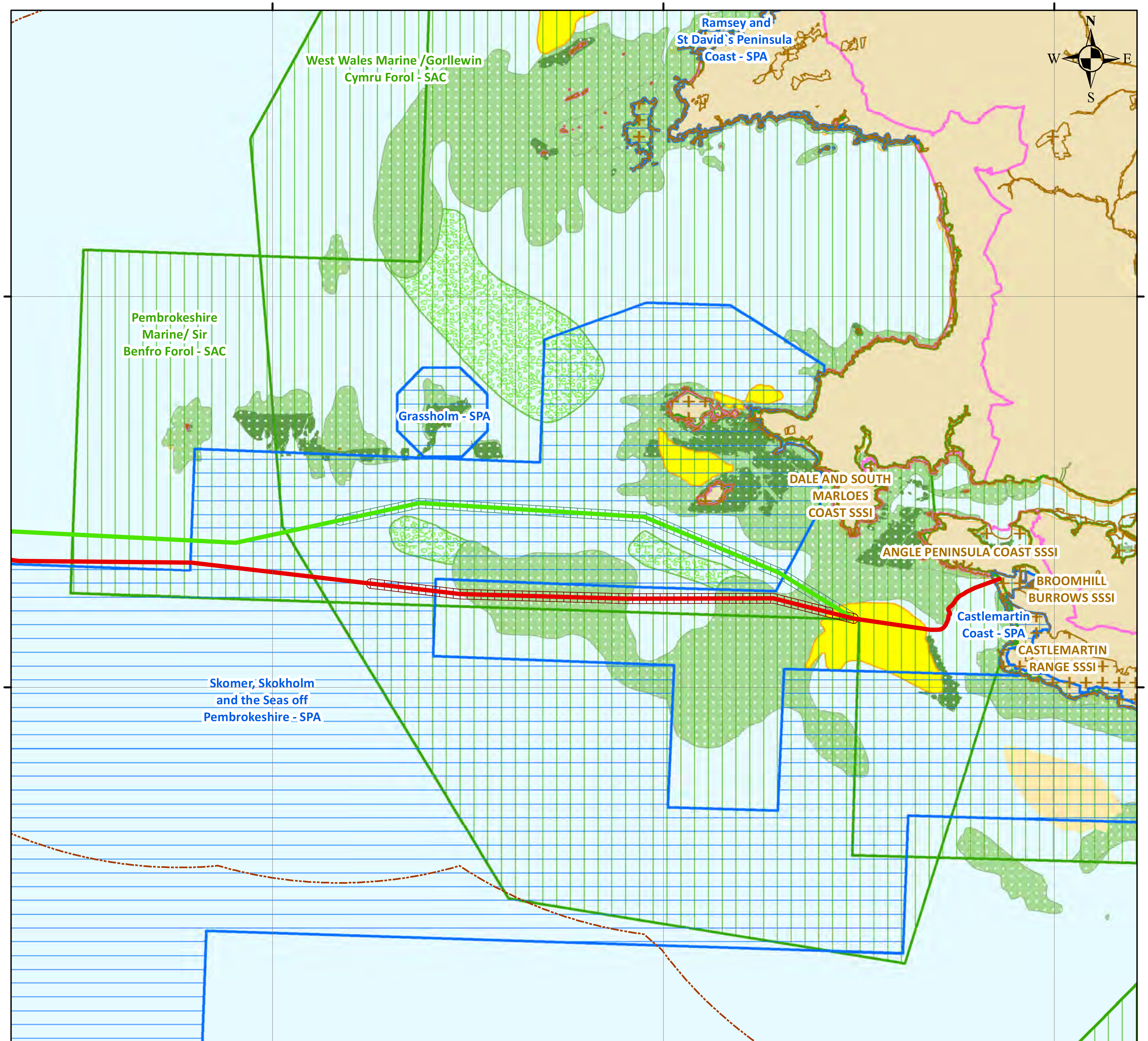
NOTE: Not to be used for Navigation

Date	Friday, April 12, 2019 15:33:23
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	JNCC; NRW; GEBCO; UKHO; CDA; MarineFind; Greenlink
File Reference	J:\P1975\Mxd\01_LOC\P1975-LOC-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

intertek

0 3 6 9 12 km



GREENLINK INTERCONNECTOR

ROUTE OVERVIEW
UK Route Development

Drawing No: P1975-SURV-011	A

Legend

UK 12nm Territorial Sea Limit

Greenlink Interconnector Proposed Routes

Route A Rev1

Route E Rev1

Reconnaisance Section

Route A (24.84km)

Route E (27.62km)

Environmental Designations

SAC

SPA

SSSI

National Park

Protected Sandbank Slightly Covered by Seawater

Sandbank Area (High Confidence)

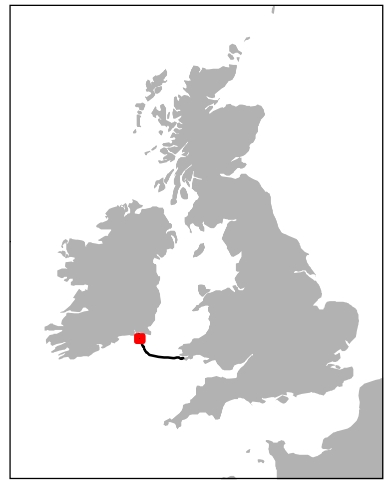
Potential Sandbank

Potential Reef

Bedrock (High Confidence)

Bedrock (Potential)

Stony (Potential)



Date	Friday, April 12, 2019 15:47:21
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	UKHO; CDA; NRW; JNCC; GEBCO; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-011.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 2 4 6 8 km

3.5.5 Route refinements during survey

Extensive route development was carried out during the cable route survey. This fell into two categories;

- minor refinements as a result of identification of potentially challenging areas for cable installation e.g. large sand waves and areas of hard ground; and
- major route development to avoid reef habitat.

3.5.5.1 Minor route refinements

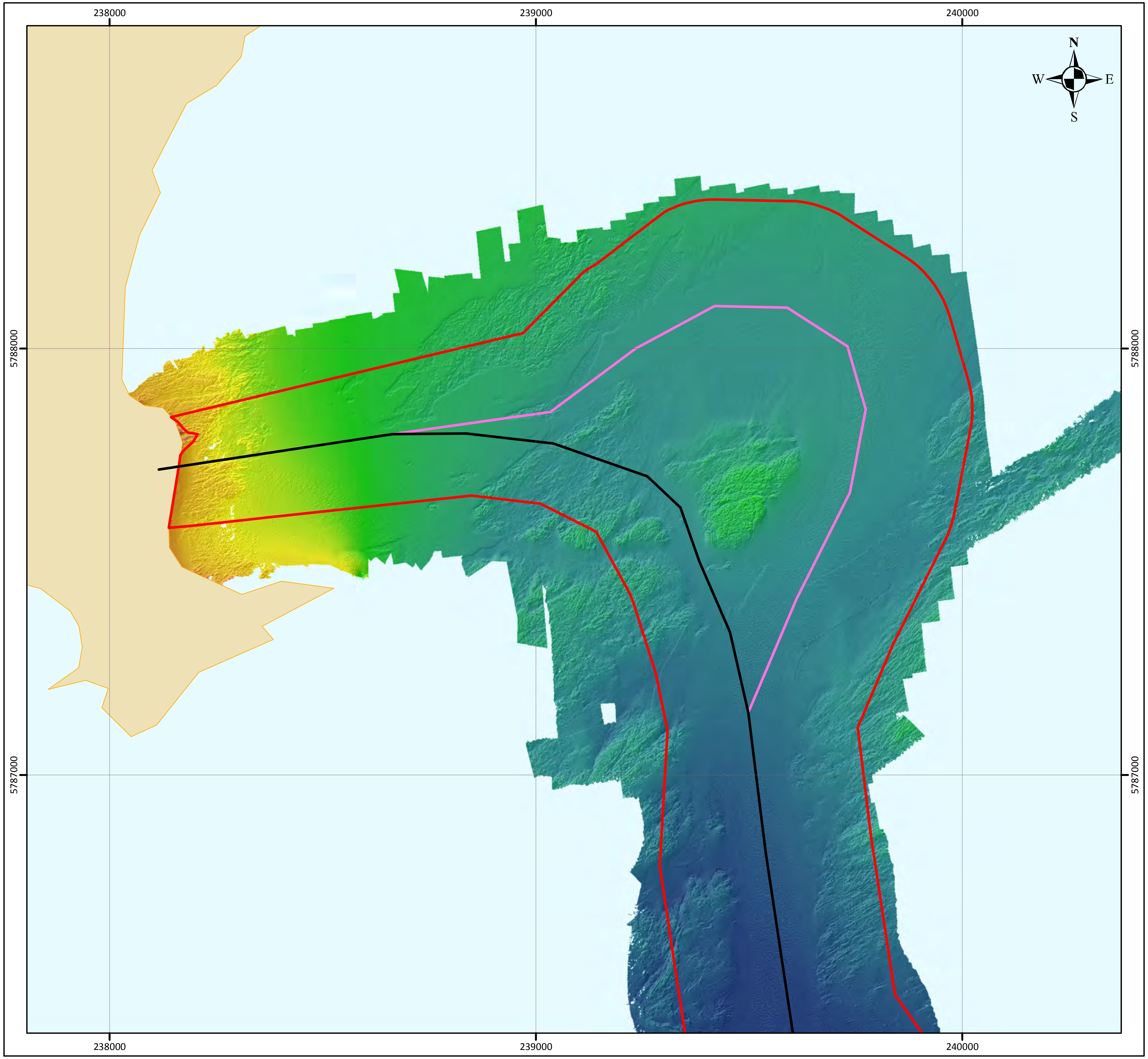
Proposed Development
On the approach to Baginbun Beach both Route A and Option D were surveyed (Figure 3-9, Drawing P1975-SURV-013). The small sand channel on Route A between outcropping rock features was approximately 35m wide at the narrowest point. This outcropping rock falls under the definition of Annex I Reef (Stony Reef); a Qualifying Interest Feature of the Hook Head SAC. Mapping of the bedrock reflector shows that installation of the cable along Route A would likely require external cable protection measures e.g. rock berm, in order to protect the cable.

However, mapping of the bedrock reflectors on Option D shows that there is sufficient sediment depth around the loop to achieve the likely required burial depths and protection for the cables. Therefore, although Option D increases the length of the cables, it has been selected as the preferred route as it avoids the sensitive reef habitat.

Marine Wales
At KP26 large sand waves are present (Figure 3-10, Drawing P1975-SURV-004). Additional survey lines were carried out to determine the extent of the sand waves and investigate the feasibility of routeing around them. The sand waves proved to be a sequence of sand waves that were too extensive, and a route around was not viable. No change to the indicative centreline could be made.

Pre-survey analysis of available SEACAMS bathymetric data provided by Bangor University identified a possible sandy channel system within the extensive rock outcrop (potential Annex I reef habitat) in nearshore Wales. The survey was engineered to acquire data over a 500m corridor with the intent to highlight more of the channel system within the bedrock.

Once the survey was outside the area covered by the SEACAMS data it was identified that the channel system deviated outside the initial survey corridor. Therefore, additional geophysical survey data was acquired showing that it was possible to follow the channel system northwest of the original route. A route was then developed to follow the channel avoiding the outcropping rock where possible, and survey data collected along this alignment; shown in Figure 3-11 (Drawing P1975-SURV-001). Survey data confirmed that there is likely to be sufficient sediment depth within the channel to achieve the likely required burial depths and protection for the cables.



GREENLINK INTERCONNECTOR

SURVEY DATA

Survey Bathymetry for Route A and Option D

Drawing No: P1975-SURV-013	A

Legend

Greenlink Interconnector Proposed Routes

- Route A Rev1
- Option D Rev1
- Proposed Development

Surveyed Bathymetry

Depth Below LAT (m)

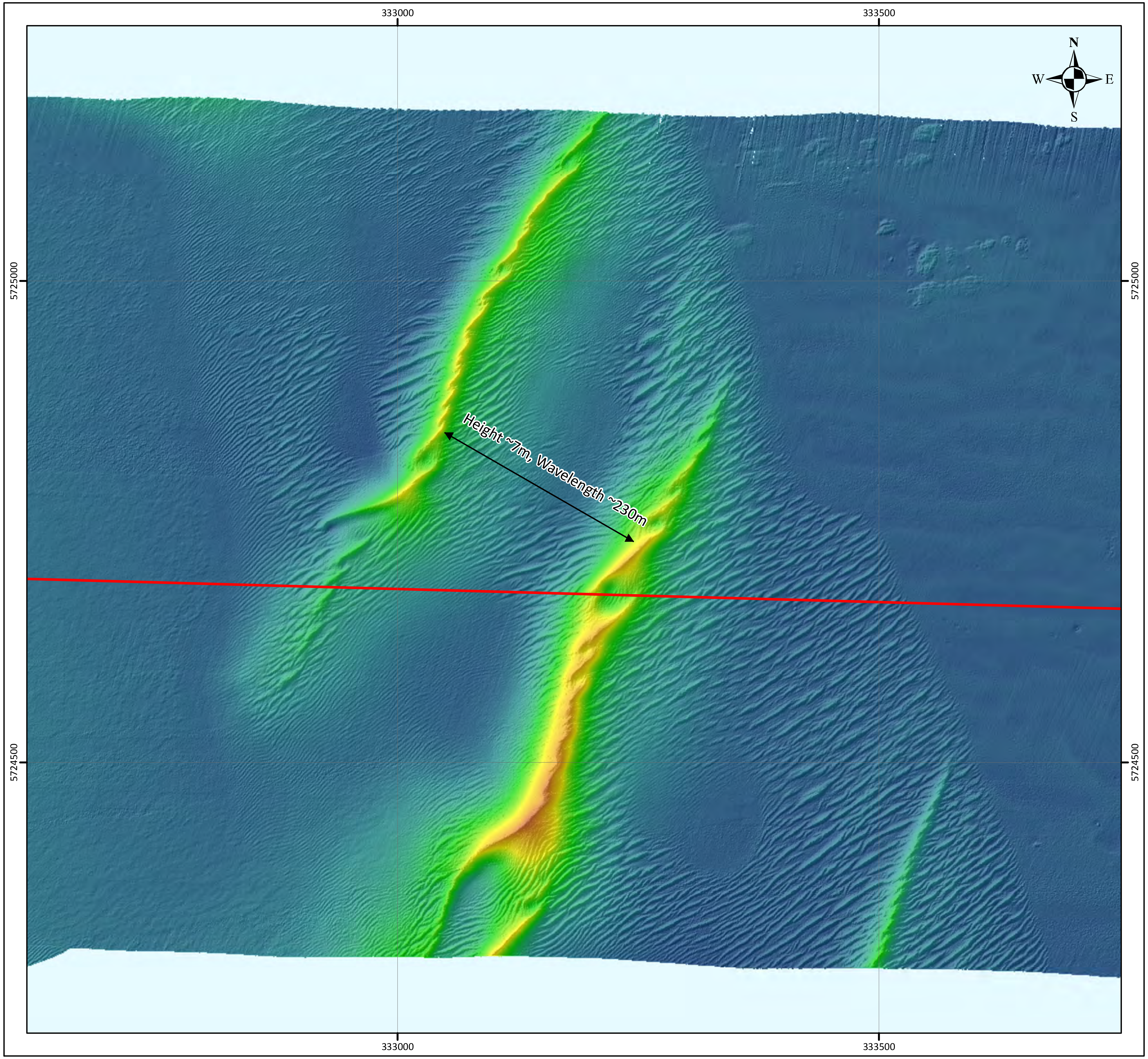
High : 20

Low : -10

Date	Thursday, April 25, 2019 08:27:56
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-013.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 100 200 300 400



GREENLINK INTERCONNECTOR
SURVEY DATA
Bathymetry over Large Sandwave Area

Drawing No: P1975-SURV-004 | **A**

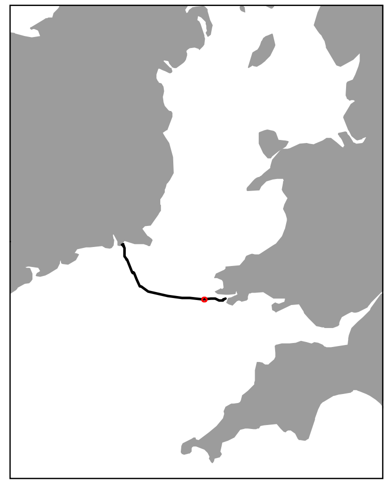
Legend

Post Survey Centreline

Survey Bathymetry Below LAT (m)

High : 60

Low : 45

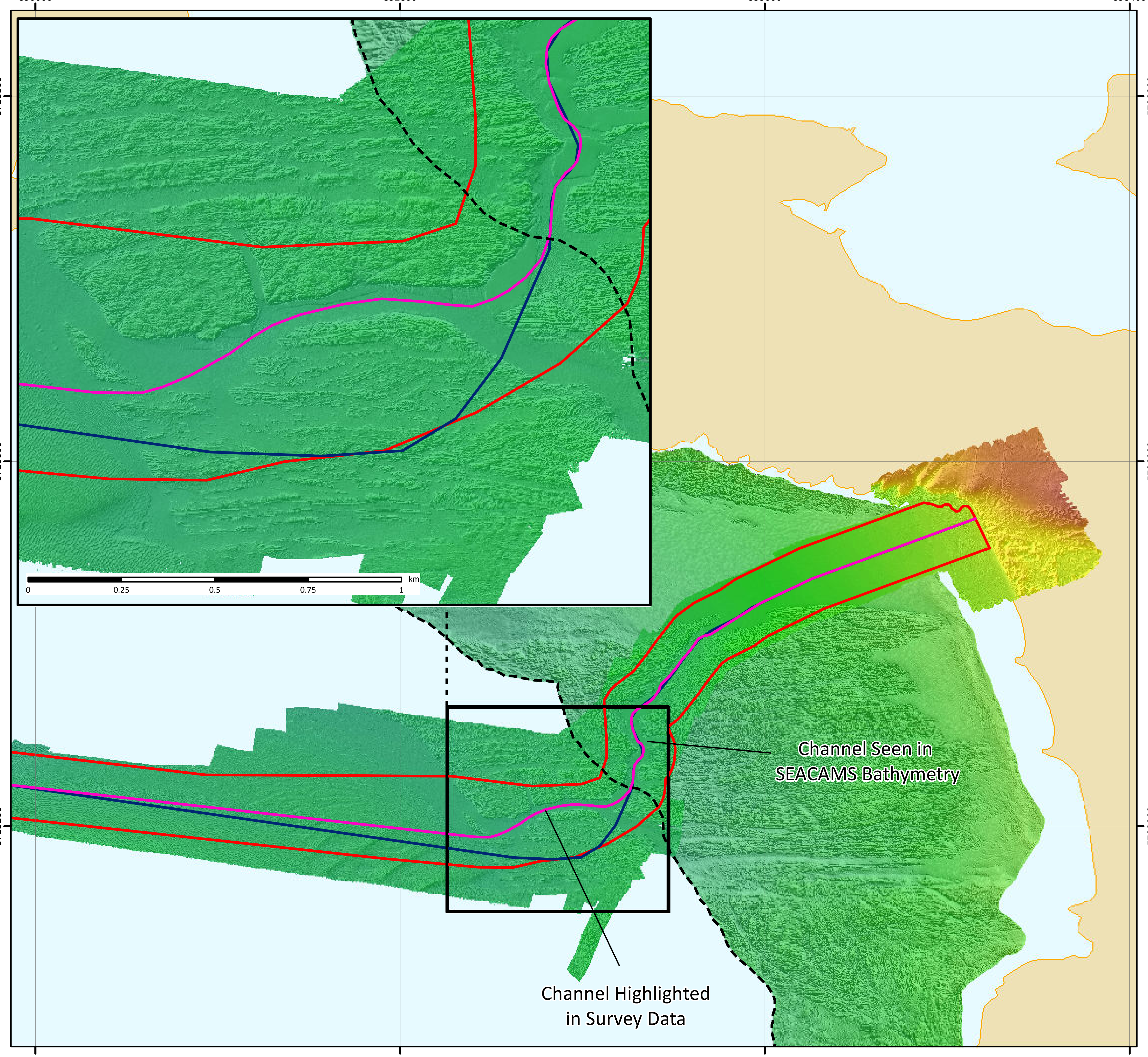


NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 13:07:54
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	ESRI; OSOD; MMT; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-004.mxd
Created By	Chris Carroll
Reviewed By	Chris Goode
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 50 100 150 200 m



GREENLINK INTERCONNECTOR

SURVEY DATA

Bathymetry Nearshore Freshwater West

Drawing No: P1975-SURV-001	A

Legend

- Post Survey Centreline
- Pre-Survey Centreline
- Proposed Development
- Desktop Bathymetry Extent

Survey Bathymetry Below LAT (m)

High : 80

Low : -80

N E S W

Date	Monday, April 8, 2019 12:52:17
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	ESRI; OSOD; Bangor University; MMT; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-001.mxd
Created By	Chris Carroll
Reviewed By	Chris Goode
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.25 0.5 0.75 1 km

3.5.5.2 Major route development

The major route development focused on the route within Marine Wales, but has been included for information purposes as it sought to avoid or reduce the route length across Annex I Reef habitat.

On completion of the reconnaissance survey of Route A and Route E biotope maps, seabed photographs and an interpretive report were submitted to NRW for review. These identified extensive areas of Annex I Reef habitat on both routes. The Conservation Objectives for the Pembrokeshire Marine SAC for Annex I Reef habitat is that "*The overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing*".

Having reviewed the extent of the Annex I Reef biotopes described for the eastern section of Route A, NRW concluded:

"due to the extent of the reef and the type of reef habitats contained within, the presence of a cable and associated construction work and protective covering would compromise the conservation objectives of the feature, should this section of Route A be used. (NRW 2018a)"

The same rationale applied for the eastern sections of Route E where Annex I reef feature has been identified throughout the width of the corridor, the loss of reef in that area would also be too great to be considered insignificant.

NRW (2018a) recommended that additional geophysical survey be completed to the eastern end of the reconnaissance survey area between Route A and Route E.

Two north-south geophysical survey lines were run between Route E and Route A (Figure 3-12, Drawing P1975-SURV-012) to identify if possible, the northern extent of the bedrock outcrop which formed the reef feature on Route A. The additional geophysical lines showed the top of the bedrock slightly north of the extent of the Route A survey corridor. This led to a route being designed between Route E and Route A that avoided the sensitive reef habitat on both routes (Figure 3-12, Drawing P1975-SURV-012).

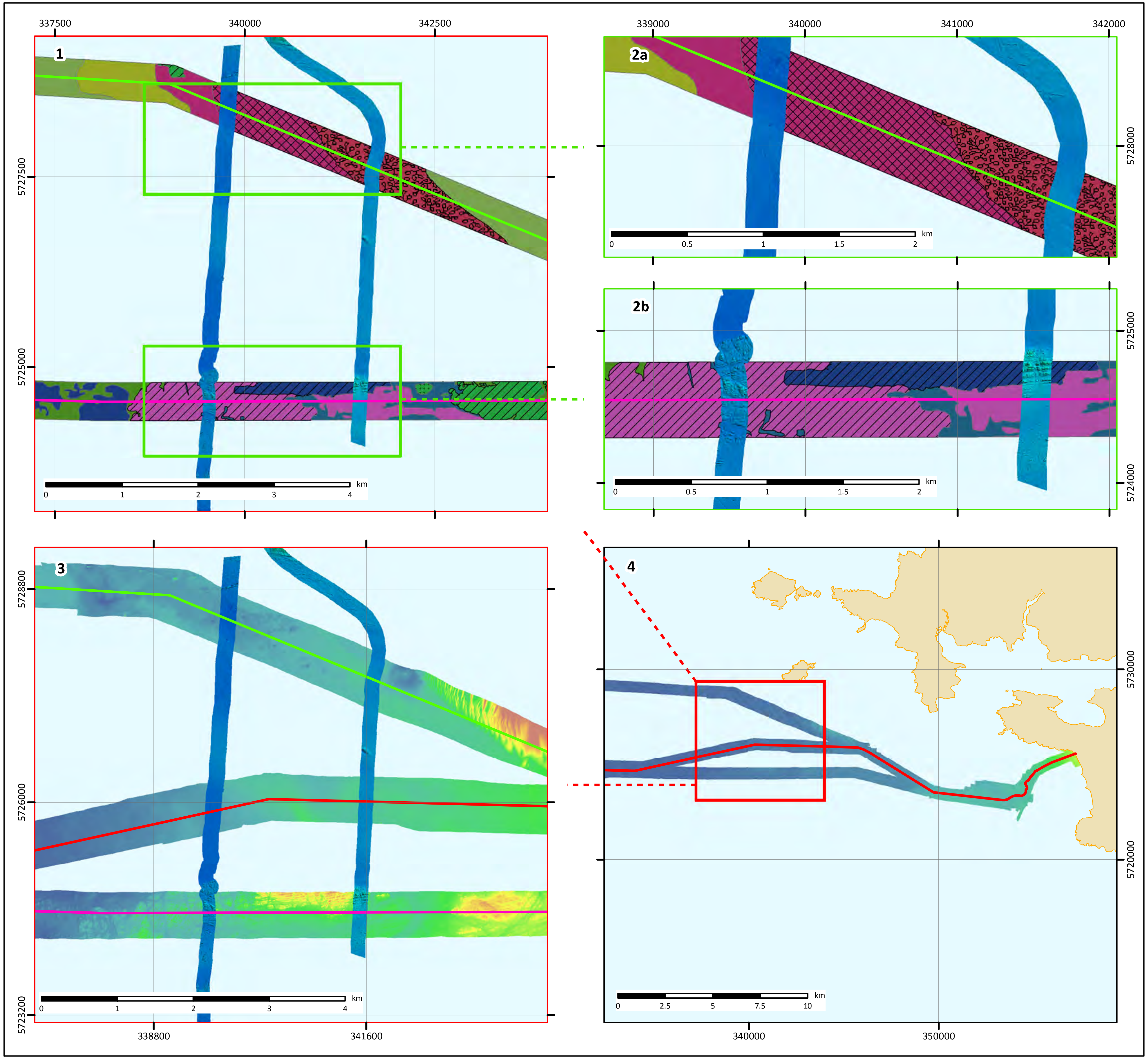
Seabed photographs, a biotope map and interpretative report were subsequently submitted to NRW for the new route section for review. NRW (2018b) considered the biotope to be present should be classified as A5.141 or SS.SCS.CCS.SpiB "*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles". NRW considers this biotope forms part of the Annex I Reef (stony reef) habitat. However, NRW (2018b) advice concluded:

"NRW considers that this alternative route is likely to be preferable to routes A and E because:

- *The cobble/sediment biotope identified, potentially A5.141, will have a low sensitivity to the cable lay. If the cable is buried within this biotope, and covered with the existing sediments, recovery will occur as the sediments are routinely scoured and moved by wave and tidal action. As stated in the JNCC biotope description for A5.141 "This biotope is characterized by a few* *ubiquitous robust and/or fast growing ephemeral species which are able to colonise pebbles and unstable cobbles and slates which are regularly moved by wave and tidal action" and long-lived or delicate species are not regularly present.*

- *There are boulders and other potential Annex I habitats including Sabellaria reef present. The side scan and drop-down video however appear to indicate that these habitats can be avoiding through micro-siting of the cable.*

At this stage, and without prejudice to later comments made during the application phase, NRW would not consider that there would be significant issues with laying a cable within A5.141, should burial of the cable be possible within this habitat with covering of local sediments from A5.141 biotope. (NRW 2018b)"



GREENLINK INTERCONNECTOR
SURVEY DATA
Survey Routeing to Avoid Sensitive Habitat
Post NRW Consultation

Drawing No: P1975-SURV-012	A

Legend

- Greenlink Route Centreline (Indicative)
- Route A Rev 1
- Route E Rev 1

BIOTOPE CLASSIFICATION

- A5.44 - Circalittoral mixed sediments
- A4.13 - Mixed faunal turf communities on circalittoral rock
- A4.131 - Bryozoan turf and erect sponges on tide-swept circalittoral rock
- A4.22 - Sabellaria reefs on circalittoral rock
- A4.24 - Mussel beds on circalittoral rock
- A5.14 - Circalittoral coarse sediment
- A5.25 - Circalittoral fine sand
- A5.45 - Deep circalittoral mixed sediments
- A5.611 - Sabellaria spinulosa on stable circalittoral mixed sediment
- Potential AnnexI (1170) - Bedrock Reefs
- Potential Annex I (1170) - Biogenic Reef
- Potential Annex I (1170) - Low Graded Biogenic Reef
- Potential Annex I (1170) - Stony Reefs

Survey Bathymetry
Depth Below LAT (m)

High : 60.55

Low : 32.97

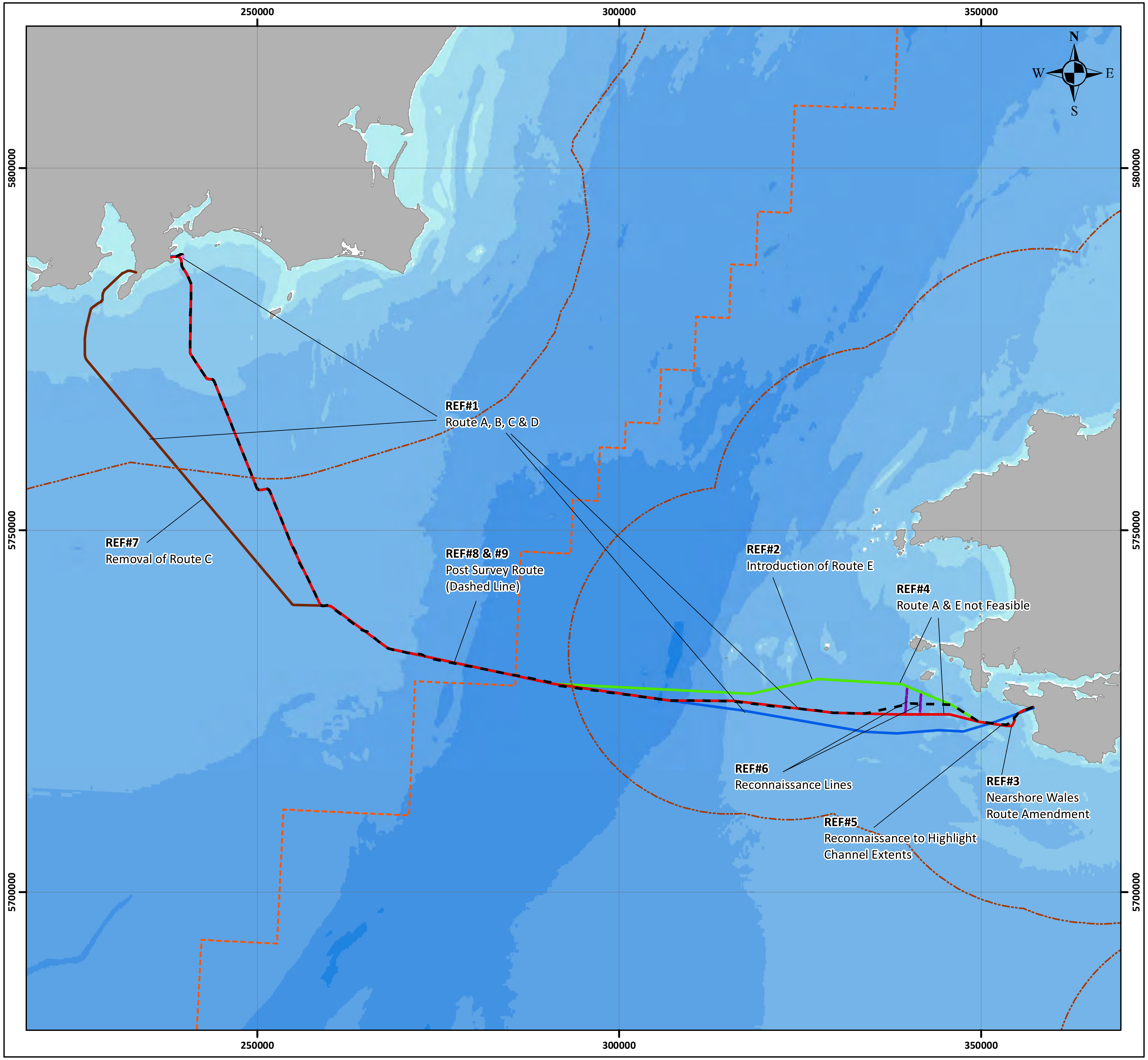
Date	Wednesday, April 10, 2019 09:44:20
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSOD; MMT; Greenlink
File Reference	J:\P1975\Mxd\02_SURV\ P1975-SURV-012.mxd
Created By	Chris Goode
Reviewed By	Chris Carroll
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

3.5.6 Summary of Route Development

The following flow diagram summarises the route evolution of the indicative Greenlink centreline and how the routes were developed during the offshore survey campaign. The reference numbers on the left hand side are to be read in conjunction with Figure 3-13 below (P1975-LOC-008-A).

REF#1 **Pre-Survey proposed routes**	• **Route A** – Preferred route from Freshwater West, Wales to Baginbun, Ireland • **Route B** – Route deviated to the south of a disposal area and into Castlemartin Firing Range • **Route C** - Route to different landfall (Boyce's Bay) in Ireland in case the preferred landfall, Baginbun, was not feasible • **Route D** – Small additional route at the Irish nearshore to avoid outcrop
REF#2 **New route to reduce impacts of crossing a designated reef feature**	• **Route E** – CMS (Greenlink lawyers, 18 April 2018) raised the concern that as reef is a designating feature of the Pembrokeshire Marine SAC, the project will need to demonstrate that all possible alternatives have been considered.
REF#3 **Amendment to nearshore Wales routes**	• **Route A & Route E Rev1** – Amended at the Welsh nearshore area and have been engineered into a natural channel within outcropping rock (Identified in the SEACAMS data). These are now displayed as Rev1. With the introduction of Route E, Route B was dropped.
REF#4 **Reconnaissance surveys along Route A and Route E**	• **Route A & Route E Rev1 –** Surveys carried out in October 2018 showed both routes contained area identified as an Annex 1 habitat and were not feasible.
REF#5 **Reconnaissance survey to highlight channel extents**	• **Route A & Route E Rev1** – The full extent of the channel area was not highlighted in the SEACAMS data therefore additional reconnaissance bathymetry lines were acquired to visualise a wider area to highlight where the channel ended and if it was feasible to practically install a cable.
REF#6 **Re-routed area avoiding Annex 1 habitats identified on Route A & Route E**	• **Re-Routed area** – North-South Reconnaissance lines were carried out between Route A and E to find the extent of outcrop associated with the Annex 1 habitat. Once the outcrop was highlighted, Geophysical Survey data was acquired within a new East-West oriented survey corridor which joined Route E to A.
REF#7 **Excluding Route C from Geophysical investigation work**	• **Route C** – Once survey was complete on the preferred Route A in Ireland and that the preferred landfall at Baginbun was confirmed as feasible, Route C was removed.
REF#8 **Post Survey Centre Line**	• **Greenlink_WGS84_UTM30N_09112018_Rev0** – The post Survey Greenlink route has used a combination of Route A, Route E, Route D, the re-routed area to avoid Annex 1 habitats and reconnaissance at the end of the old river channel area to arrive at a single route centreline.
REF#9 **Post Survey Centre Line Rev1**	• **Greenlink_WGS84_UTM30N_09112018_Rev1 –** Further refinement of the Greenlink route using processed survey data to avoid identified constraints and areas interpreted as Annex 1 habitat.



GREENLINK INTERCONNECTOR

ROUTE OVERVIEW

Pre Survey & Post Survey Route Centre Lines

Drawing No: P1975-LOC-008	A

Legend

Post Survey Route Centre Line

- Greenlink Route Cenreline (Indicative)*
- Median Line
- 12nm Territorial Sea Limit

Pre Survey Route Centre Line

- Route A Rev1
- Route B Rev0
- Option C Rev0
- Option D Rev1
- Route E Rev1

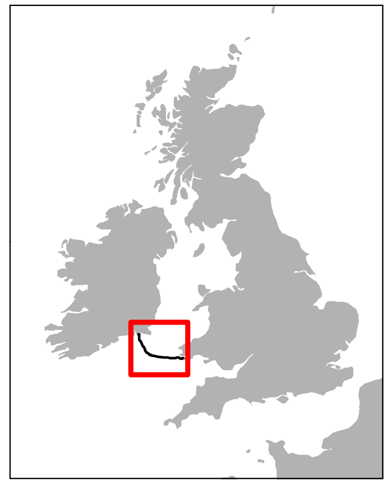
Survey Reconnaissance Lines

- North South Reconnaissance Lines

Bathymetry (m)

- -150 - -125
- -125 - -100
- -100 - -75
- -75 - -50
- -50 - -20
- -20 - -10
- -10 - 0

*Greenlink_WGS84_UTM30N_05042019_Rev1.shp



Date	Monday, April 29, 2019 13:57:11
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	CDA; UKHO; DCCAE; GEBCO; EMODNET; ESRI;
File Reference	J:\P1975\Mxd\01_LOC\ P1975-LOC-008.mxd
Created By	Chris Carroll
Reviewed By	Chris Goode
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 5 10 15 20 km

3.6 Summary of Alternatives

Table 3-3 summarises the alternatives considered and the environmental considerations behind the decision to discount options.

Table 3-3 Summary of alternatives

Category	Option	Description and Environmental Considerations	Decision
Strategy	Do Nothing	• The 'do nothing' option dictates that generation of electricity needs to be based in the country where it is used and constrains export of electricity when generation exceeds demand. • Option is not supported by Irish government and EU policy as it goes against the European Commission's priorities and commitments to combating climate change.	DISCOUNTED
	Install Interconnector	• Increases the transmission capacity between countries and improves security of supply. • Supports the growth and integration of low carbon energy. • Greenlink has been awarded Project of Common Interest (PCI) status by the European Commission, making it one of Europe's most important energy infrastructure projects and granting it the "highest national significance" possible.	SELECTED
Technology	HVAC	• HVAC interconnector between the Irish and GB grids is not technically and economically feasible as: - The Irish and British grids are not "synchronized",- without this synchronization, power cannot be successfully transmitted between the grids with an HVAC interconnector; - The capacity of HVAC underground or subsea cables to transmit power reduces significantly with distance travelled such that an HVAC interconnector would not be an economic means to transmit power between Ireland and GB • HVDC cable is the more efficient technology experiencing lower losses (e.g. heat) when compared to HVAC cable.	DISCOUNTED
	HVDC		SELECTED
Connection Point	Great Island	• Following a network review the most suitable location on the east of the Irish Transmission Network was found to be the Great Island Substation in County Wexford.	SELECTED

Category	Option	Description and Environmental Considerations	Decision
Landfall / Offshore route	Direct to Great Island via River Barrow	• Would require routeing through the River Barrow and River Nore SAC an important spawning area for Annex II listed fish species including Salmon, Twaite shad and three lamprey species. • Would require technically challenging shallow water installation. Substantial constraints in the form of navigation channels, dredged channels and designated anchor zones. • Port of Waterford Company had significant concerns about any route within the estuary.	DISCOUNTED
	Baginbun Beach	• Offers the shortest overall offshore cable route length and met the technical requirements other landfalls fell short on. • A sand channel with sufficient depth to achieve cable burial has been confirmed during the cable route survey through the Hook Head SAC, ensuring significant adverse effects on the Reef Qualifying Interest can be avoided.	SELECTED
	Sandeel Bay	• Sandeel Bay was de-selected when analysis of INFOMAR bathymetric data identified likely extensive reef habitat offshore. Any route to the landfall would likely require extensive external cable protection on the Qualifying Interest Reef. It could not be discounted that this would not lead to significant adverse effects on the Hook Head SAC.	DISCOUNTED
	Boyce's Bay	• The Port of Waterford Company expressed strong reservations regarding the route as it entered the shipping channel. The Port Company required the cable route to be as close to the headland as possible, an area which may have only a veneer of sediment overlying rock which would likely result in external rock protection being required. • The outcropping rock is likely to be Annex I Reef (Stony Reef) habitat and although not within the Hook Head SAC, forms part of the wider habitat for which the site is designated. • The landfall was discounted in 2018 when the cable route survey confirmed a route into Baginbun Beach was feasible.	DISCOUNTED
	Booley Bay	• Consultation with the Port of Waterford was undertaken on 09 March 2016. A 100m wide corridor (marked on Admiralty Chart) is dredged at Duncannon	DISCOUNTED

Category	Option	Description and Environmental Considerations	Decision
		approximately 3-4 times a year, to stop the shipping channel from silting up. The offshore approach to the landfall would intersect this area risking both the ports activities and the cable. Therefore, Booley Bay was dropped from further consideration on environmental grounds as it would have a significant effect on another marine user.	

3.7 Proposed Development

The final Greenlink route being taken forward for consent in Ireland and Wales is shown in Figure 1-1 (P1975-LOC-001). Figure 3-14 (Drawing P1975-CORR-002) presents the Proposed Development in Ireland. An indicative centreline is shown on the Figure, noting that this will be subject to change as micro-routeing is undertaken within the consented corridor by the Installation Contractor.

The advantages of the final route, in comparison to alternative routes considered are:

Proposed Development

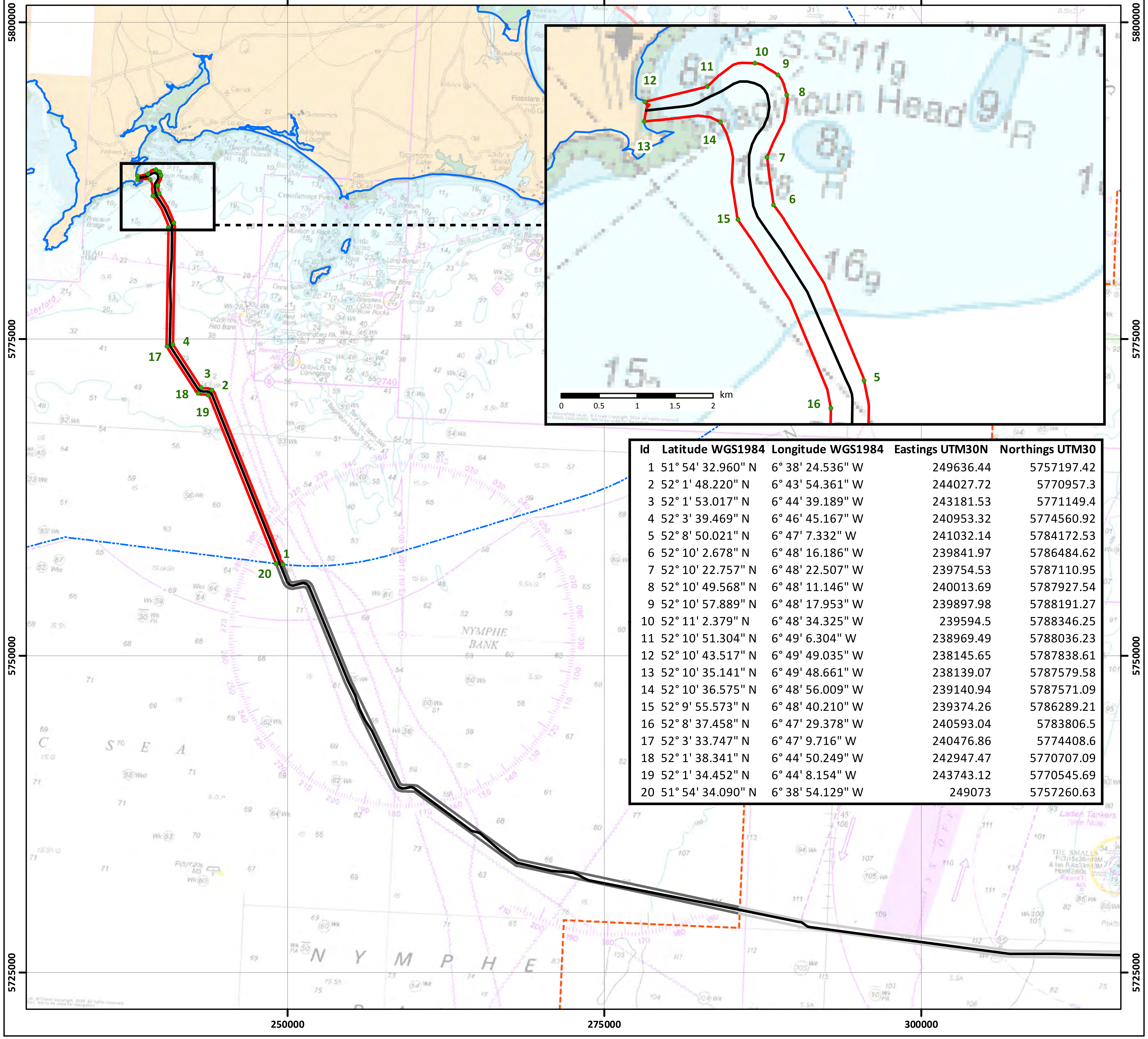
- The installation solution at the landfall has been selected as horizontal directional drilling, which will ensure that intertidal Annex I reef habitat is not affected by the Proposed Development, and disruption to the recreational use of the beach is minimised.
- The route uses an existing sand channel between extensive Annex I reef habitat within the Hook Head SAC. Survey has confirmed that the sand channel contains adequate sediment cover to allow full burial of the Greenlink cables; although a contingency to place external cable protection at the HDD exit points is being considered as a worst case.
- The route avoids shipping channels in to and out of Port of Waterford.

Offshore Ireland

- The route avoids the extensive area of sand waves by routeing to the south.

Marine Wales

- The route minimises the area of Annex I reef habitat crossed and avoids the most sensitive habitats where cable installation may have significantly affected the conservation objectives of the Pembrokeshire Marine SAC.
- The route minimises the length within the Castlemartin Firing Range while avoiding other constraints such as presence of Annex I reef and historical dumping sites.



Id	Latitude WGS1984	Longitude WGS1984	Eastings UTM30N	Northings UTM30
1	51° 54' 32.960" N	6° 38' 24.536" W	249636.44	5757197.42
2	52° 1' 48.220" N	6° 43' 54.361" W	244027.72	5770957.3
3	52° 1' 53.017" N	6° 44' 39.189" W	243181.53	5771149.4
4	52° 3' 39.469" N	6° 46' 45.167" W	240953.32	5774560.92
5	52° 8' 50.021" N	6° 47' 7.332" W	241032.14	5784172.53
6	52° 10' 2.678" N	6° 48' 16.186" W	239841.97	5786484.62
7	52° 10' 22.757" N	6° 48' 22.507" W	239754.53	5787110.95
8	52° 10' 49.568" N	6° 48' 11.146" W	240013.69	5787927.54
9	52° 10' 57.889" N	6° 48' 17.953" W	239897.98	5788191.27
10	52° 11' 2.379" N	6° 48' 34.325" W	239594.5	5788346.25
11	52° 10' 51.304" N	6° 49' 6.304" W	238969.49	5788036.23
12	52° 10' 43.517" N	6° 49' 49.035" W	238145.65	5787838.61
13	52° 10' 35.141" N	6° 49' 48.661" W	238139.07	5787579.58
14	52° 10' 36.575" N	6° 48' 56.009" W	239140.94	5787571.09
15	52° 9' 55.573" N	6° 48' 40.210" W	239374.26	5786289.21
16	52° 8' 37.458" N	6° 47' 29.378" W	240593.04	5783806.5
17	52° 3' 33.747" N	6° 47' 9.716" W	240476.86	5774408.6
18	52° 1' 38.341" N	6° 44' 50.249" W	242947.47	5770707.09
19	52° 1' 34.452" N	6° 44' 8.154" W	243743.12	5770545.69
20	51° 54' 34.090" N	6° 38' 54.129" W	249073	5757260.63

GREENLINK INTERCONNECTOR

PROPOSE DEVELOPMENT

ROI Waters

Drawing No: P1975-CORR-002 | **A**

Legend

- Application Area Points
- Greenlink Route Centreline (Indicative)
- Proposed Development
- Irish Offshore
- Wales Marine
- ROI Mean High Water
- ROI 12nm Territorial Sea Limit
- Median Line

NOTE: Not to be used for Navigation

Date	Tuesday, April 23, 2019 08:39:30
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; OSI; CDA; GEBCO; UKHO; MarineFind
File Reference	J:\P1975\Mxd\03_CORR\ P1975-CORR-002.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union Connecting Europe Facility

0 3 6 9 12 km

REFERENCES

1 European Commission (EC) (2017). Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions. Communication on strengthening Europe's energy networks. Brussels 23.11.2017. COM(2017) 718 final.

2 Intertek EWCS (2015). Greenlink Interconnector Route Selection Report, P1975_RN3929_Rev1, December 2015.

3 Intertek EWCS (2016a). Greenlink Interconnector Route Selection Report, P1975_RN3929_Rev2, January 2016.

4 Intertek EWCS (2016b). Greenlink Interconnector Route Selection, P1975_BN3952_Rev1, February 2016

5 Intertek EWCS (2018a). Greenlink Cable Route Report, P1975_BN4437_Rev1, February 2018

6 Intertek EWCS (2018b). Greenlink Cable Route Report, P1975_BN4437_Rev2, August 2018

7 Intertek EWCS (2019). Greenlink Cable Route Report, P1975_BN4437_Rev3, April 2019.

8 NRW (2018a). Pre-application advice to Greenlink/Intertek EWCS. 07 December 2018.

9 NRW (2018b). NRW advice on Routes A and E. Pre-application advice to Greenlink/Intertek EWCS. 12 October 2018.

Appendix B

Greenlink Marine Environmental Impact Assessment – Ireland, Chapter 7 – Estuarine, Intertidal and Benthic Ecology

7. Benthic and Intertidal Ecology

This Chapter describes the existing baseline environment in terms of the benthic and intertidal ecology, identifies the pressures associated with the Proposed Development and Campile Estuary on the receptor, presents the findings of the environmental impact assessment, and describes how significant effects (if any) will be mitigated.

The Proposed Development refers to the Irish Marine components of Greenlink from mean high-water springs (MHWS) at the Irish landfall at Baginbun Beach, Co. Wexford to the 12nm limit. It comprises:

- Two high voltage direct current (HVDC) electricity power cables;
- A smaller fibre-optic cable for control and communication purposes;
- All associated works required to install test, commission and complete the aforementioned cables; and
- All associated works required to operate, maintain, repair and decommission the aforementioned cables, including five repair events over the 40 year lifetime of Greenlink.

The Proposed Development includes the following phases, all of which are assessed within this chapter:

- Installation;
- Operation (including repair and maintenance activities); and
- Decommissioning.

This chapter also provides information on the Irish Offshore components of Greenlink from the 12nm limit to the Republic of Ireland/UK median line.

The Campile Estuary component of Greenlink lies along the onshore cable route. Horizontal directional drilling (HDD) will be used to cross the River Campile. The bores will be at a depth of >10m below the river bed. As the bores under the estuary cross the Foreshore, they will be included within the Foreshore Licence application, and therefore the significance of any effects on the estuary ecology has been assessed in this chapter. The compounds from which the HDD will initiate and terminate will be either side of the estuary, setback above MHWS, and are outside the scope of this EIAR. A separate EIAR will be prepared for the Irish Onshore components of Greenlink, which will include the HDD compounds.

7.1 Data Sources

Greenlink Interconnector Limited (GIL) has commissioned environmental and intertidal surveys to inform the baseline description and assessment. These have been supplemented where necessary by a review of published information and consultation with relevant bodies. The data sources used in this Chapter include, but are not limited to the following:

- Greenlink Interconnector Environmental Survey Report (MMT 2019) – provided as Technical Appendix H;
- Greenlink Interconnector Cable Landfall Locations (Wales and Ireland) – Intertidal Walkover Survey Report 2018 (MarineSpace 2018) – provided as Technical Appendix I;
- Ecological Assessment of estuarine habitats at Campile estuary and terrestrial ecology in proximity to Baginbun Beach for a proposed electricity interconnector between Ireland and Wales (Dixon.Brosnan 2019);
- The Marine Life Information Network (MarLIN) website; and
- Other data sources as listed at the end of the Chapter.

7.1.1 Intertidal survey

Data regarding the intertidal area of Baginbun Beach is not readily available. Therefore, GIL commissioned MarineSpace to undertake a phase 1 intertidal walkover survey of the Baginbun Beach landfall to inform the baseline description and assessment.

Conducted on the 12 September 2018, it involved surveying all intertidal habitats between MHWS and mean low water springs (MLWS) across a 500m wide area centred on the indicative cable centreline. The Proposed Development lies within the surveyed area.

The intertidal survey was undertaken during spring tides in line with guidance in the Marine Monitoring Handbook (Davies *et al* 2001) and Countryside Council for Wales (CCW) Handbook for Marine Intertidal Phase I Survey and Mapping (Wyn *et al* 2006). During the walkover survey, biotopes were identified according to the European Nature Information System (EUNIS) classification in line with relevant guidance (Parry 2015) (and correlated to the Marine Nature Conservation Recorder (MNCR) biotopes). Where possible, boundaries of biotopes were tracked using handheld Garmin E-Trex 10 GPS devices and the Phase One Habitat Survey Tool Kit application (v1.4.0).

Soft and hard substrate quadrat sampling was undertaken to gather detailed information on the benthic communities present for biotope mapping purposes. Areas representative of each key soft sediment habitat at different tidal heights were assessed by sampling the upper 10cm of a 0.04m^2 (0.2 m x 0.2 m) quadrat using a spade and screened on a 0.5 mm sieve. Any macrobenthos retained on the sieve was identified to species level where possible in the field. The quadrats were then dug to ~ 30 cm depth to check for the presence of larger, burrowing species. Any soft sediment samples were subject to a visual inspection and observations of colour, smell, redox potential discontinuity (RPD) depth layer, texture and presence of surface features (accretions, algae, fauna, etc.) recorded.

The survey report is provided as Technical Appendix I.

7.1.2 Offshore survey

As part of the comprehensive survey of the Greenlink cable route, MMT was commissioned by GIL to characterise the benthic ecological conditions and map the distribution and extent of the marine benthic habitats along the route. Marine survey work was undertaken between the 30 September 2018 and the 01 January 2019.

Geophysical, geotechnical and benthic survey techniques were used to:

- Identify obstructions and debris on the seabed;
- Determine whether any features of conservation importance were present;
- Map benthic habitats;
- Characterise burial conditions; and
- Characterise the seabed conditions.

The scope of the geophysical and geotechnical survey is outlined in detail in Chapter 6, Section 6.1.

Geophysical data were used to focus the environmental survey strategy and subsequent data interpretation.

The benthic survey corridor was 500m wide. Survey operations were undertaken in accordance with the procedural guidelines contained within the marine monitoring handbook (Davies *et al*. 2001).

Benthic samples were collected using two types of grab samples (Day grab, and Hamon grab); selection depended on the sediment size. Sample locations were selected based on the geophysical interpretation, emphasising variations in the seabed characteristics, along with investigation of areas of notable interest (e.g. areas of potential conservation importance).

Three grab samples were retrieved at each selected site; two sample for macrofaunal analysis; and one sample for particle size and chemical analysis. Sidescan sonar data interpretation was confirmed using selected drop-down video/photo and/or grab samples.

A total of 17 sites were sampled in Irish waters; 7 within the Proposed Development (Stations S00 to S06) and 10 in the Irish Offshore (Stations S07 to S16) (Figure 7-1).

Prior to grab sampling, seabed still images were collected using a SeaSpyder drop-down video (DDV) system. These were reviewed by experienced marine biologists on board to confirm the presence/absence of any potentially sensitive habitats or features of conservation importance. Where grab sampling was not possible due to hard seabed or coarse substrates, only video/still photo was used for sampling.

Three video transects were performed within the nearshore area of the Proposed Development to investigate areas of potential interest (DDV_T01, DDV_T02, DDV_T03) (Figure 7-1). However, no habitats or associated fauna was recorded due to very poor visibility from suspended sediment in the water column (mobilised by recent storm conditions). DDV_T02 did show kelp on bedrock. No transects were undertaken in the Irish Offshore.

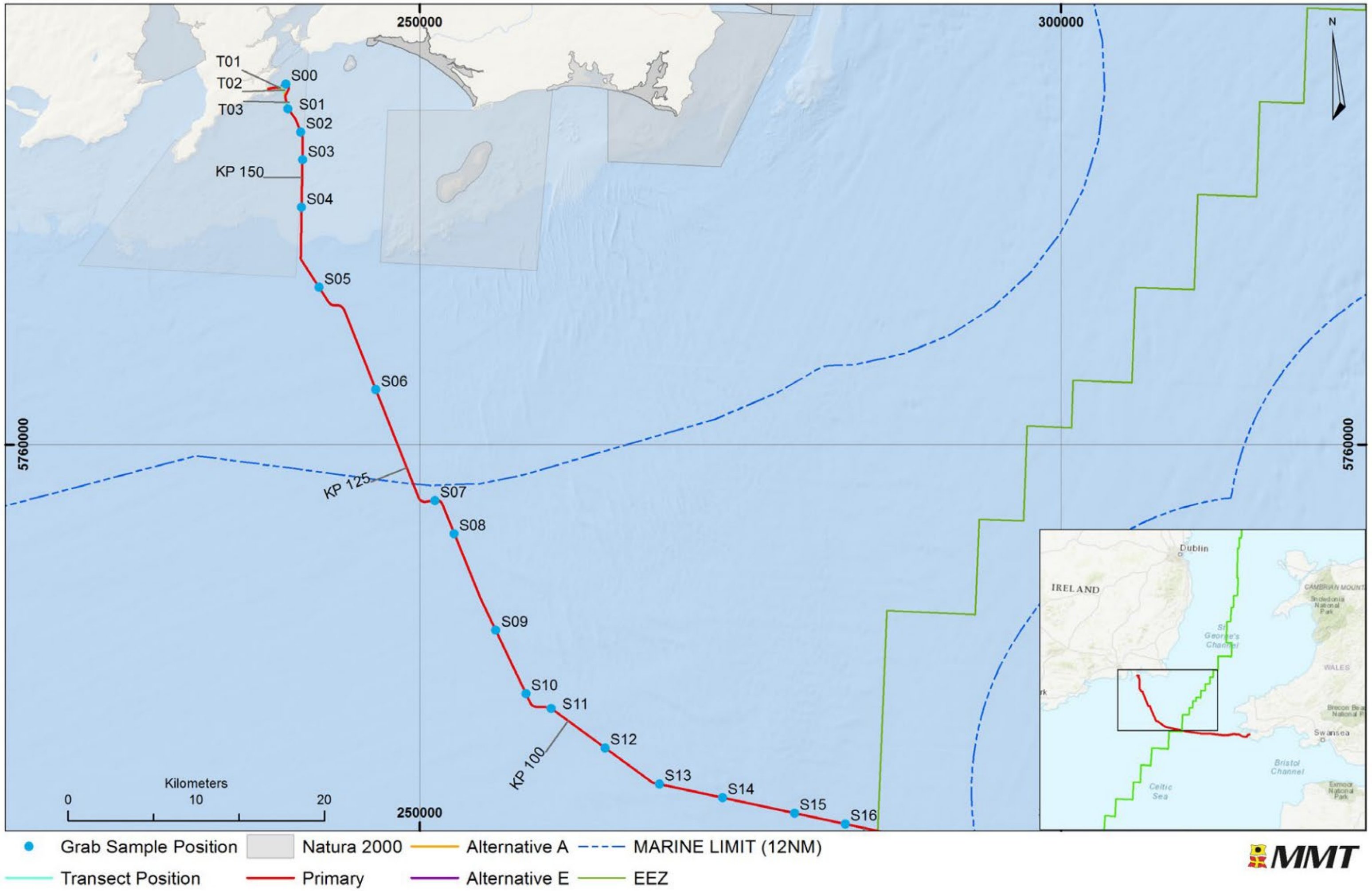
Underwater visibility was generally good, although very poor conditions were experienced in the nearshore area i.e. at transects DDV_T01, DDV_T02, DDV_T03.

Collectively, information from the grab sampling, video/photo analysis, sidescan sonar and multi-beam echosounder was used to classify habitats and associated epibenthic communities to biotopes where possible and/or to habitat/biotope complex according to the European Union Nature Information System (EUNIS) classification code and Annex I habitats. Particular attention was paid to habitats above the elevated seabed level, together with their spatial extent, percentage biogenic cover and patchiness, as these are key criteria for evaluating areas of conservation importance and reef structures.

Faunal identification and quantification were carried out for grab samples and still photographs to obtain species density data of individuals per m^2 and percentage cover for colonial species.

The survey report is provided as Technical Appendix H.

Figure 7-1 Grab sample and drop down video transect positions



Co-financed by the European Union
Connecting Europe Facility

7.2 Consultation

Table 7-1 summarises the relevant consultation responses on benthic and intertidal ecology. The steps taken to contact stakeholders for comments on the EIA scope is documented in Chapter 5.

Table 7-1 Consultation responses – intertidal, benthic and estuarine ecology

Stakeholder	Summary of Consultation Response	How response has been addressed
Foreshore Unit	A description of the biological environment over which the activity would impact, including the terrestrial flora and fauna, must be included	A description of the environmental baseline is included in Section 7.3. Information has been taken and summarised from the baseline surveys provided as Technical Appendices H and I. Effects on terrestrial fauna and flora above MHWS will be assessed in the Irish Onshore EIAR.
Foreshore Unit	The Foreshore Unit commented that in their opinion burial in a sand channel within the SAC would only have an ethereal impact, with pre-impact conditions reached within 6 months; and would therefore be preferable to the use of external cable protection.	Foreshore Unit opinion has been taken into consideration when conducting the assessment presented in Section 7.6.

7.3 Existing Baseline

7.3.1 Overview

Benthic ecology describes the assemblages of organisms living in (infauna) or on (epifauna) the seabed, and their diversity, abundance and function. Benthic communities include those found on the sea floor from the intertidal zone to the deepest parts of the marine environment. The structure of benthic communities varies temporally and spatially depending on a wide range of physical factors of which water depth, sediment type, particle size and supply of organic matter are key variables.

Seabed conditions along the Proposed Development were identified as typical of the southeast coast of Ireland, which predominantly consist of sandy gravel with nearshore areas of sand (JNCC 2004). The British Geological Survey (BGS) has categorised these sediments as patchy with areas of exposed bedrock close to the shore.

The Proposed Development crosses the Hook Head Special Area of Conservation (SAC) from KP159.267 at the Baginbun Beach landfall to KP151.258. The SAC comprises marine subtidal reefs to the south and east of the Hook Head Peninsula and sea cliffs from Hook Head to Baginbun and Ingard Point. The substrate around the Hook Head Peninsula gives rise to a range of benthic fauna. This is partly due to the strong tides and water currents which bring new supplies of food and nutrients.

An exposed to moderately exposed reef community complex occurs around Hook Head. Subtidally the reefs are aligned in a north-east/south-west orientation and are typically strewn with boulders, cobbles and patches of sand and gravel. There are also a number of isolated reefs that project from a sand plain. The reefs present a high species richness with Laminaria dominated communities in shallower waters. The deeper waters consist of Echinoderm and sponge dominated communities characterised by cushion sponges, branching sponges and the rose coral *Pentapora foliacea*. The rare red algae *Schizymenia dubyi* also occurs (NPWS 2016).

Habitat maps of the Hook Head SAC were obtained from NPWS and combined with bathymetry data from INFOMAR were used to select the route for the Proposed Development (see Chapter 3).

Further offshore, sediments are more sandy and homogenous (MMT 2019).

A total of 12 habitats were identified by the benthic survey in Irish waters, most of which were classified as sandy habitats.

7.3.2 Baginbun Beach intertidal ecology and habitats

The intertidal zone at Baginbun Beach contains a complex mosaic of littoral rock platforms and sand filled gullies supporting a variety of biotopes. Figure 7-2 shows the Beach as seen from the air; the images were taken during the Greenlink drone survey to establish the topography.

The habitat map produced by the intertidal Phase 1 walkover survey is provided as Figure 7-4.

To the south, the upper shore is dominated by barren littoral coarse sand (A2.221) with a narrow overlying strandline biotope constituted by decomposing seaweed supporting sandhopper (*Talitrid amphipods*) communities (A2.211). Fingers of sandy sediment extend down the shore filling tide swept gullies formed by fucoid dominated rocky outcrops (A1.214) (visible in Figure 7-2). These extend from the mid to the lower shore. Aggregations of *Sabellaria alveolata* tubes were noted along the rocky outcrops (Figure 7-3). To the north of the survey area, the band of barren upper shore sand is narrower and was fringed by barnacle dominated littoral rock (A1.112 / A1.113) quickly grading into fucoid dominated mid-shore rocky outcrops (A1.313 / A1.3141) that extended into a rocky platform dominated by *Fucus serratus* (A1.214) and *Laminaria digitata* along the sublittoral fringe.

A summary of biotopes found at Baginbun Beach is provided in Table 7-2.

Figure 7-2 Aerial images of Baginbun Beach September 2018

Source: MMT

Table 7-2 Key intertidal biotopes

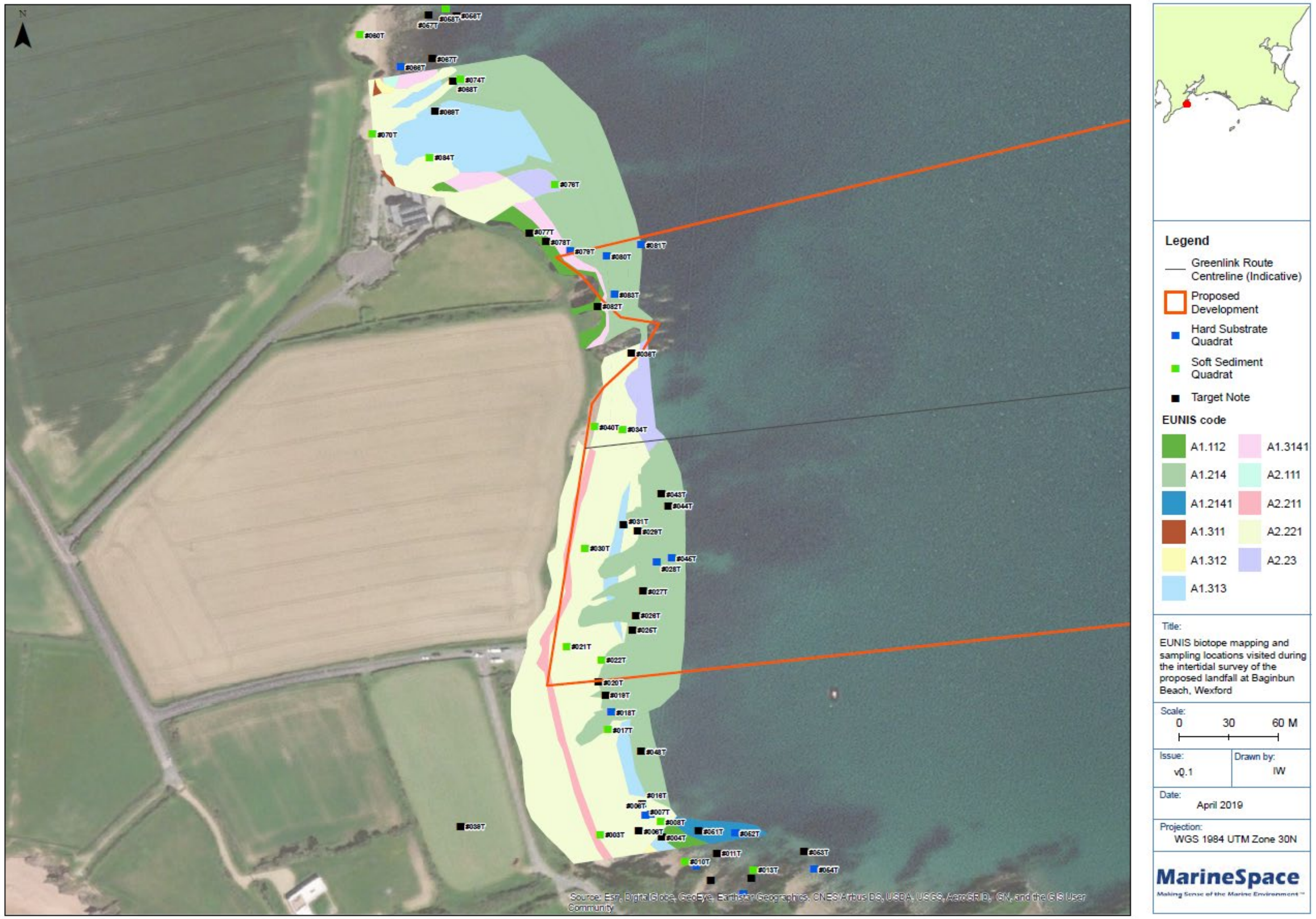
Habitat	EUNIS Code	EUNIS Description
A1 - Littoral Rock and other hard substrata	A1.113	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.214	*Fucus serratus* on moderately exposed lower eulittoral rock
	A1.2141	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
	A1.311	*Pelvetia canaliculata* on sheltered littoral fringe rock
	A1.312	*Fucus spiralis* on sheltered upper eulittoral rock
	A1.313	*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock
	A1.3141	*Ascophyllum nodosum* on full salinity mid eulittoral rock
	A1.421	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools
	A1.412	Fucoids and kelp in deep eulittoral rockpools
	A1.413	Seaweeds in sediment-floored eulittoral rockpools
A2 - Littoral sediment	A2.111	Barren littoral shingle
	A2.211	Talitrids on the upper shore and strandline
	A2.221	Barren littoral coarse sand
	A2.23	Polychaete/amphipod-dominated fine sand shores

Figure 7-3 Photographs of biotope features at Baginbun Beach

Left: Shallow upper shore rock pool feature. Right: *S. alveolata* tube aggregation in a gully on the mid-shore.

Source: MarineSpace (2018)

Figure 7-4 EUNIS biotope mapping and sampling locations at Baginbun Beach



7.3.3 Subtidal ecology and habitats

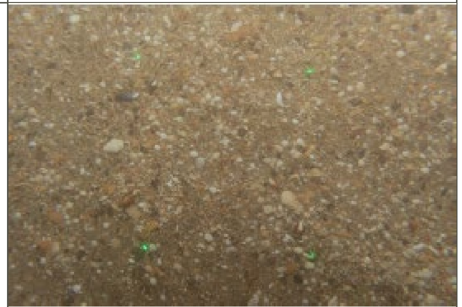
Review of the geophysical data, ground-truthed by video and still photography, and infaunal grab sample analysis identified 12 habitats within the survey corridor as described in Table 7-3. These are mapped and presented in Figure 7-5 to Figure 7-11 below (Drawings P1975-HAB-003 Sheet 12 to Sheet 06).

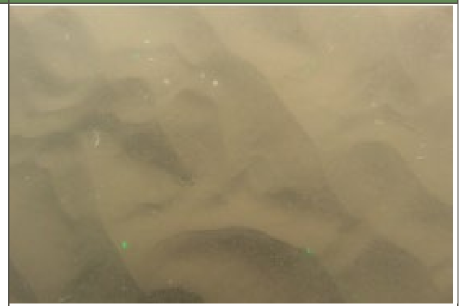
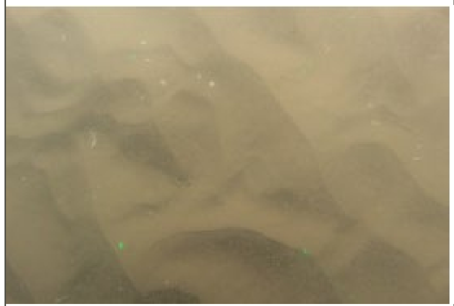
No *Sabellaria spinulosa* were identified in any of the grab samples in Irish waters.

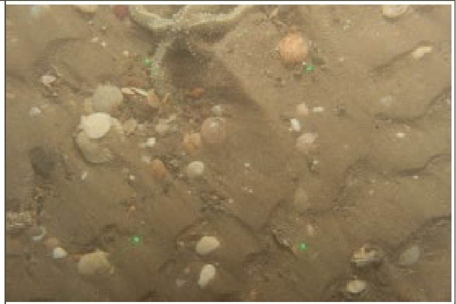
Table 7-3 Habitats present within the Proposed Development and Irish Offshore

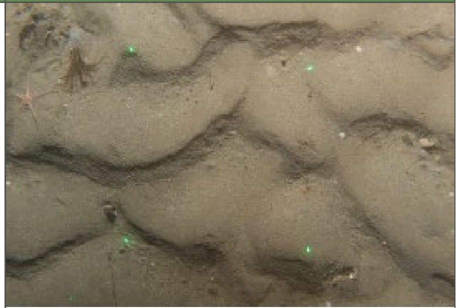
Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
Proposed Development					
Landfall	T01 S00	A3.2 - Atlantic and Mediterranean moderate energy infralittoral rock	IR.MIR - Moderate energy infralittoral rock	S00 - The infaunal composition was characterized by molluscs *A. alba*, *F. fabula*, *Spisula subtruncata* and polychaetes *M. johnstoni* and *Nephtys hombergii*.	Interpreted from side scan sonar (SSS) data
Landfall KP 159-158 KP 153 - 149	T03-T01, S01 S03, S04	A5.252 - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	S01, KP 155.639,- The infaunal analysis showed a small sample with regards to abundance and diversity which was primarily characterized by crustaceans and polychaetes. S03, KP 151.395 - The infaunal was characterised by polychaetes *O. borealis*, and *Spiophanes bombyx*, *L. cingulate*, amphipods *B. elegans*, *Urothoe elegans* and molluscs *A. prismatica* and *T. ovata*. S04, KP 147.691 characterised by molluscs Fabulina fabula, A. prismatica, N. nitidosa, Gari fervensis, polychaetes Magelona johnstoni, Magelona filiformis, N. cirrosa, amphipods Bathyporeia tenuipes, B. elegans and echinoderms E. pusillus and A. filiformis.	

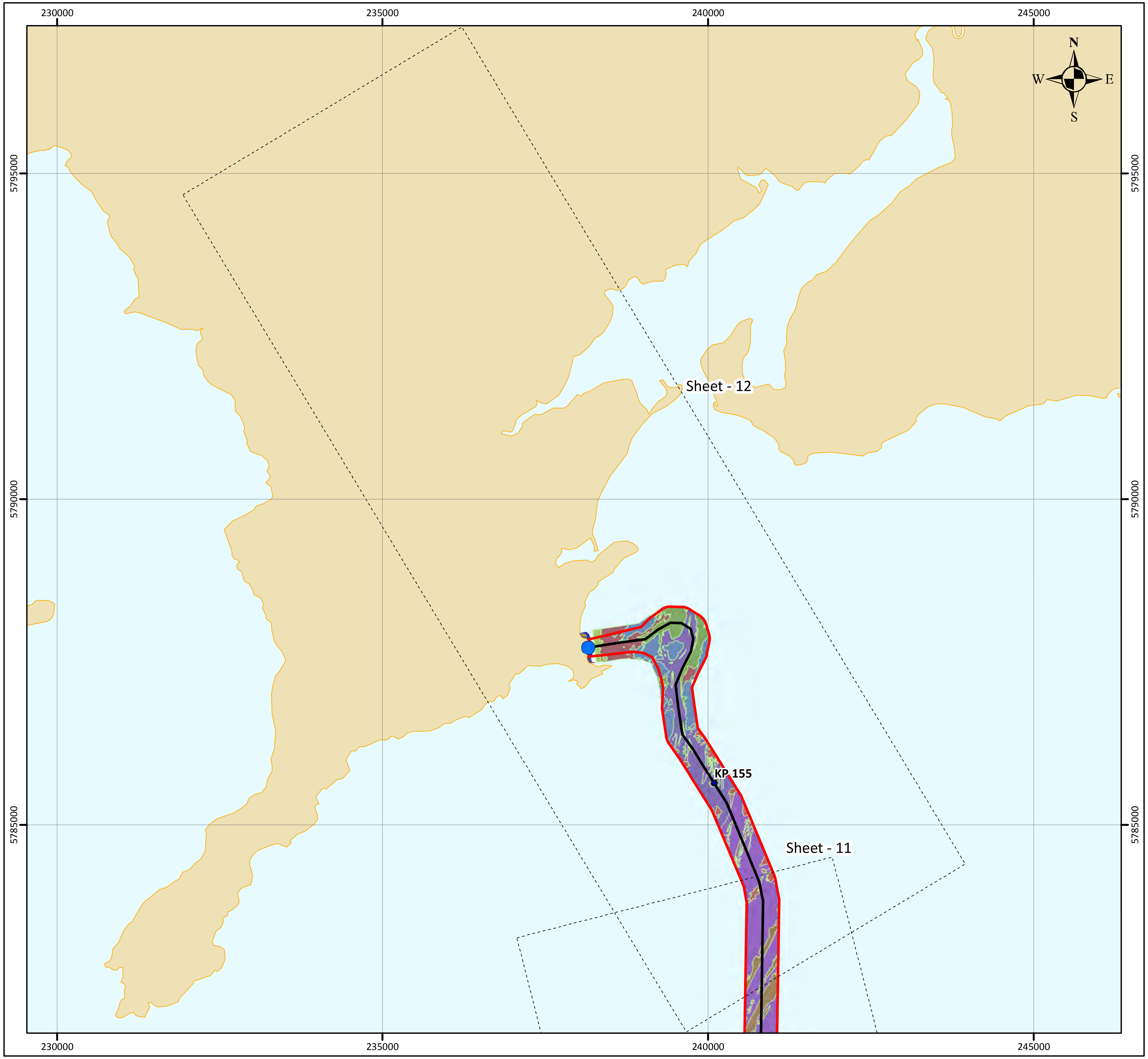
Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
KP159	S01, T01	A3.11 - Kelp with cushion fauna and/or foliose red seaweeds	IR.HIR.KFaR - Kelp with cushion fauna and/or foliose red seaweeds	S01, KP 155.639,- The infaunal analysis showed a small sample with regards to abundance and diversity which was primarily characterized by crustaceans and polychaetes.	
KP 159-158	T03-T01, S01	A5.24 - Infralittoral muddy sand	SS.SSa.IMuSa - Infralittoral muddy sand		
KP158-156	TO3-T01, S01	A5.44 - Circalittoral mixed sediments	SS.SMx.CMx - Circalittoral mixed sediments		Interpreted from SSS data

Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
KP 156 - 154	T03, S01	A5.25 - Circalittoral fine sand	SS.SSa.CFiSa - Circalittoral fine sand		
KP 153-149	S02, S03, S04	A5.14 Circalittoral coarse sediment	SS.SCS.CCS - Circalittoral coarse sediment	S02, KP.153.593 - Infaunal composition was characterised by polychaetes *Pista mediterranea*, *Psamathe fusca*, echinoderms *Amphipholis squamata*, holothurian *Thyone fusus*, molluscs *Gari telinella* and *Clausinella fasciata*. S03, KP 151.395 - The infaunal was characterised by polychaetes *O. borealis*, and *Spiophanes bombyx*, *L. cingulate*, amphipods *B. elegans*, *Urothoe elegans* and molluscs *A. prismatica* and *T. ovata*. S04, KP 147.691 characterised by molluscs Fabulina fabula, A. prismatica, N. nitidosa, Gari fervensis, polychaetes Magelona johnstoni, Magelona filiformis, N. cirrosa, amphipods Bathyporeia tenuipes, B. elegans and echinoderms E. pusillus and A. filiformis.	

Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
KP 147 - 126	S05-S04	A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	SS.SSa.IMuSa.FfabMag - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	S05, S04, KP 131.546, KP 141.046 and KP 147.691 - characterised by molluscs Fabulina fabula, A. prismatica, N. nitidosa, Gari fervensis, polychaetes Magelona johnstoni, Magelona filiformis, N. cirrosa, amphipods Bathyporeia tenuipes, B. elegans and echinoderms E. pusillus and A. filiformis.	
Irish Offshore (KP74 - KP124)					
KP126 - 118	S06 - S07	A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	SS.SSa.IMuSa.FfabMag - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	S07, S06, KP 121.090, - characterised by molluscs Fabulina fabula, A. prismatica, N. nitidosa, Gari fervensis, polychaetes Magelona johnstoni, Magelona filiformis, N. cirrosa, amphipods Bathyporeia tenuipes, B. elegans and echinoderms E. pusillus and A. filiformis.	

Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
KP 118 -105 KP 75-71	S10-S08 S16	A5.251 - Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand	SS.SSa.CFiSa.EpusObo rApri- Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand	S08, KP117.806 - No residue was acquired for analysis of infauna S09 and S10, KP 109.684 and 104.203 - The infaunal composition was similar at both locations, although less diverse and abundant at S09 than compared to S10, and was characterised by echinoderm *E. pusillus*, polychaetes *O. borealis*, and *Spiophanes bombyx*, amphipod *B. elegans* and molluscs *A. prismatica*, *T. flexuosa* and *K. bidentata.* S16, KP 76.476 - The infaunal composition was characterized by molluscs *Abra prismatica, A. alba, Phaxas pellucidus*, cumaceans *Eudorellopsis deformis*, numerous polychaetes, *B. elegans* and echinoderms *A. filiformis* and *E. pusillus*	
KP 99 - 75	S16-S12	A5.252 - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatP o - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	S16, S15, S14, S12, KP 76.476, KP 80.529, KP 86.263, KP 96.422 - The infaunal composition at these locations was characterized by molluscs *Abra prismatica, A. alba, Phaxas pellucidus*, cumaceans *Eudorellopsis deformis*, numerous polychaetes, *B. elegans* and echinoderms *A. filiformis* and *E. pusillus*. S13, KP 91.300 - the infaunal composition was characterised polychaetes *Spiophanes kroyeri, Owenia* sp., *Goniada maculata*, echinoderms *A. filiformis* and molluscs *Corbula gibba* and *Nucula hanleyi*.	

Indicative KPs	Associated Sample Station(s)	EUNIS Habitat code	JNCC Equivalent Habitat	Infaunal analyses from grab samples	Indicative habitat image
KP93, 92, 90 KP 105-100	S13 S11 S10	A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand	SS.SSa.OSa.OfusAfil - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand	S13, KP 91.300 - the infaunal composition was characterised polychaetes *Spiophanes kroyeri*, *Owenia* sp., *Goniada maculata*, echinoderms *A. filiformis* and molluscs *Corbula gibba* and *Nucula hanleyi*. S10, KP104.203 - The infaunal composition was similar at both locations, although less diverse and abundant at S09 than compared to S10, and was characterised by echinoderm *E. pusillus*, polychaetes *O. borealis*, and *Spiophanes bombyx*, amphipod *B. elegans* and molluscs *A. prismatica*, *T. flexuosa* and *K. bidentata*. S11, KP 101.624 - infaunal composition was characterized by polychaetes *Owenia sp.*, *O. borealis*, *Lagis koreni*, molluscs *Nucula nitidosa*, *C. gibba*, *Thyasira flexuosa*, echinoderms *A. filiformis* and *E. pusillus*	



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 12

Drawing No: P1975-HAB-003	**A**

Legend

- Baginbun Beach
- Greenlink Route Centreline (Indicative)
- Proposed Development

MMT Survey
EUNIS Classification

- A3.11
- A3.2
- A4.1
- A5.14
- A5.23
- A5.24
- A5.25
- A5.252
- A5.43
- A5.44

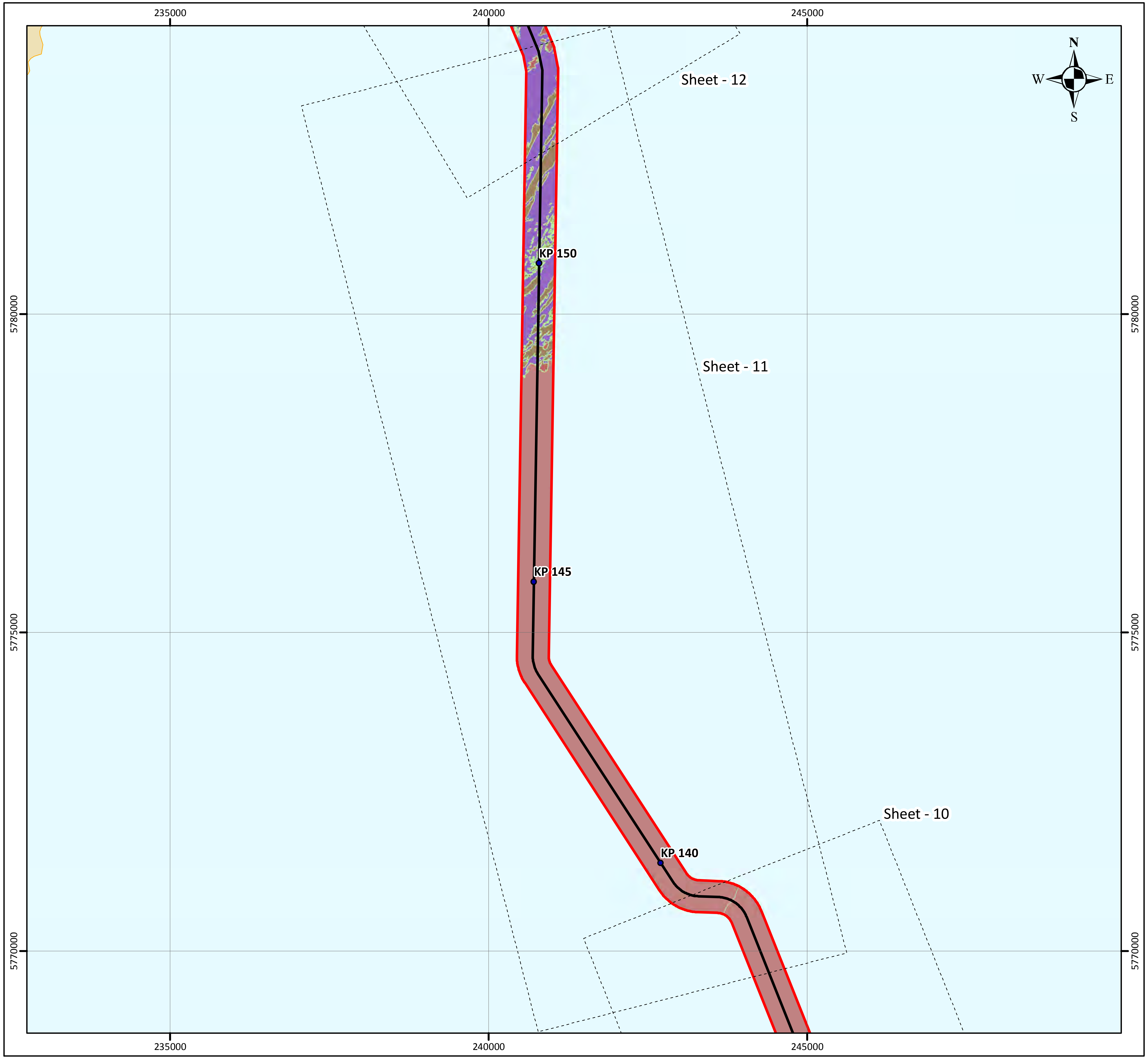
MarineSpace Survey
EUNIS Classification

- A1.112
- A1.113
- A1.214
- A1.2141
- A1.311
- A1.312
- A1.313
- A1.3141
- A2.111
- A2.211
- A2.221
- A2.23

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 11

Drawing No: P1975-HAB-003	A

Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development

MMT Survey

EUNIS Classification

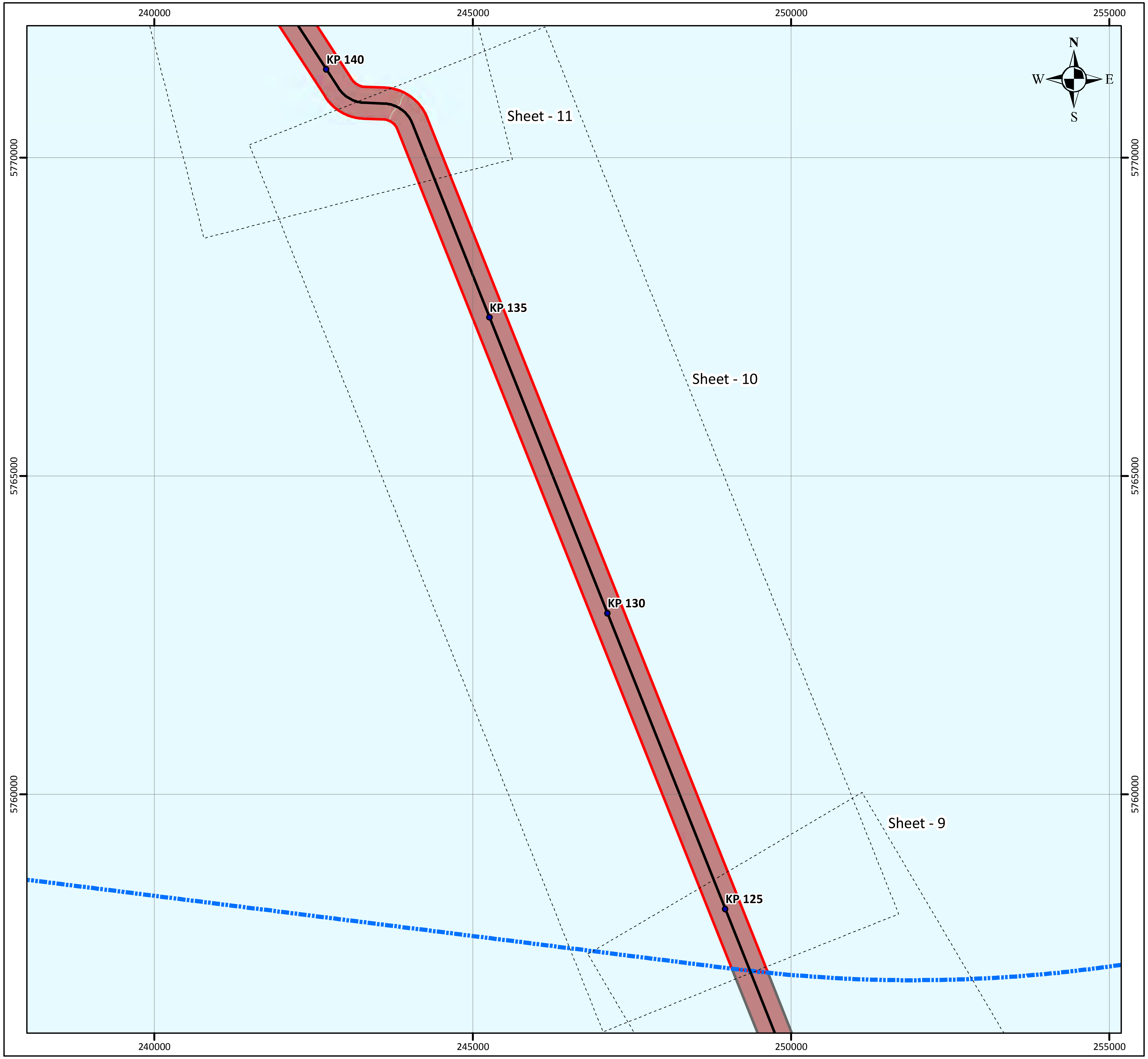
- A4.1
- A5.14
- A5.242
- A5.25
- A5.252
- A5.44

NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 10

Drawing No: P1975-HAB-003	A

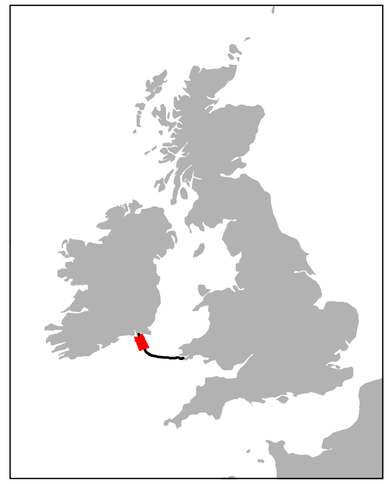
Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development
- Irish Offshore
- ROI 12nm Territorial Sea Limit

MMT Survey

EUNIS Classification

- A5.242

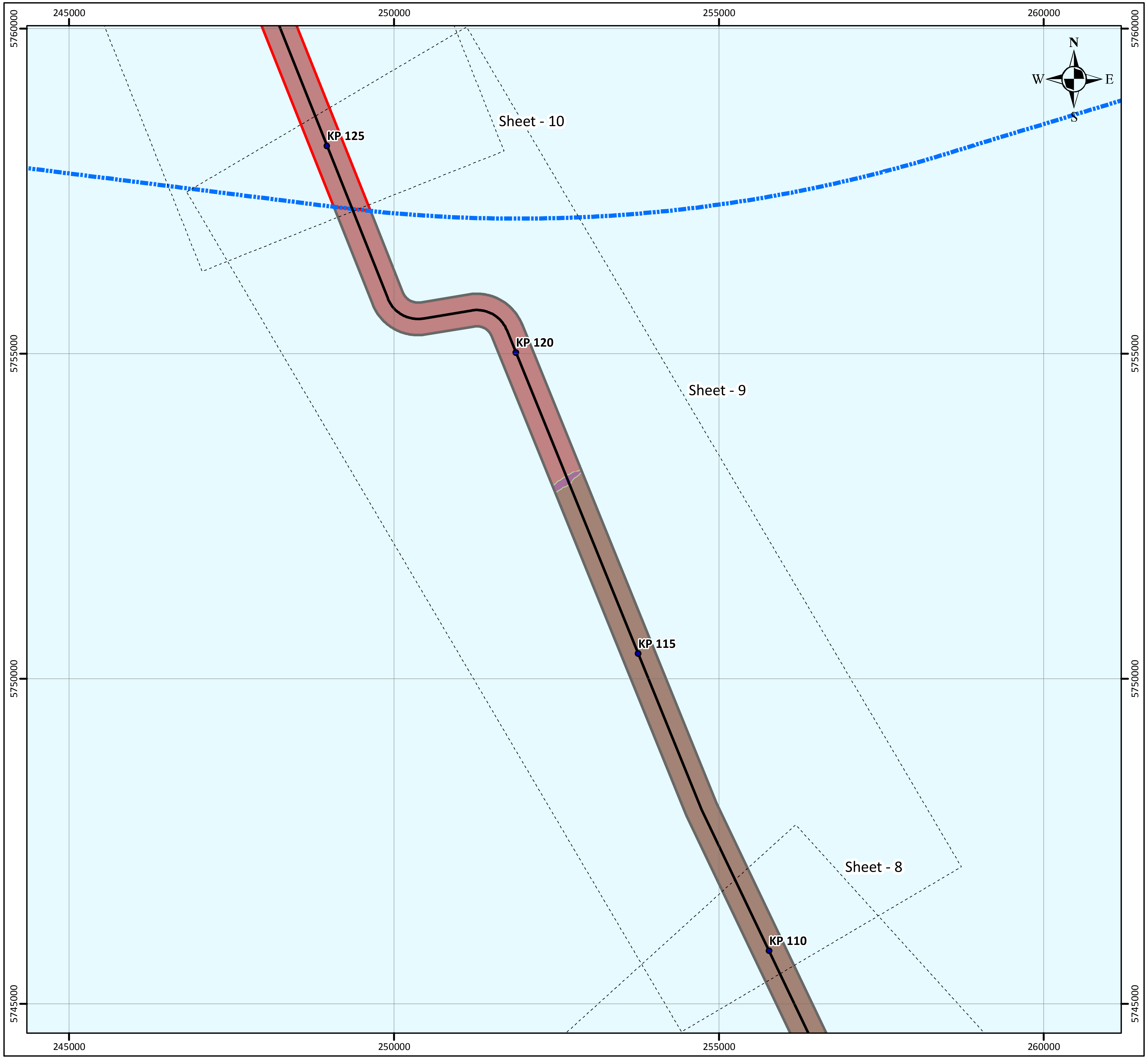


NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 9

Drawing No: P1975-HAB-003	A

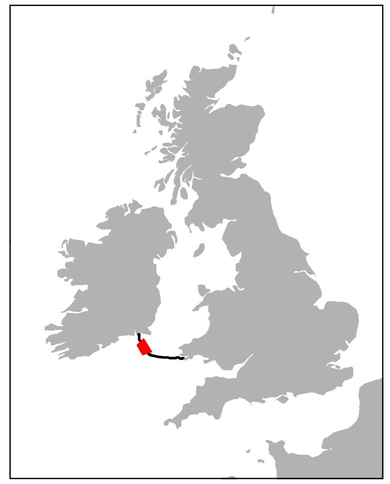
Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development
- Irish Offshore
- ROI 12nm Territorial Sea Limit

MMT Survey

EUNIS Classification

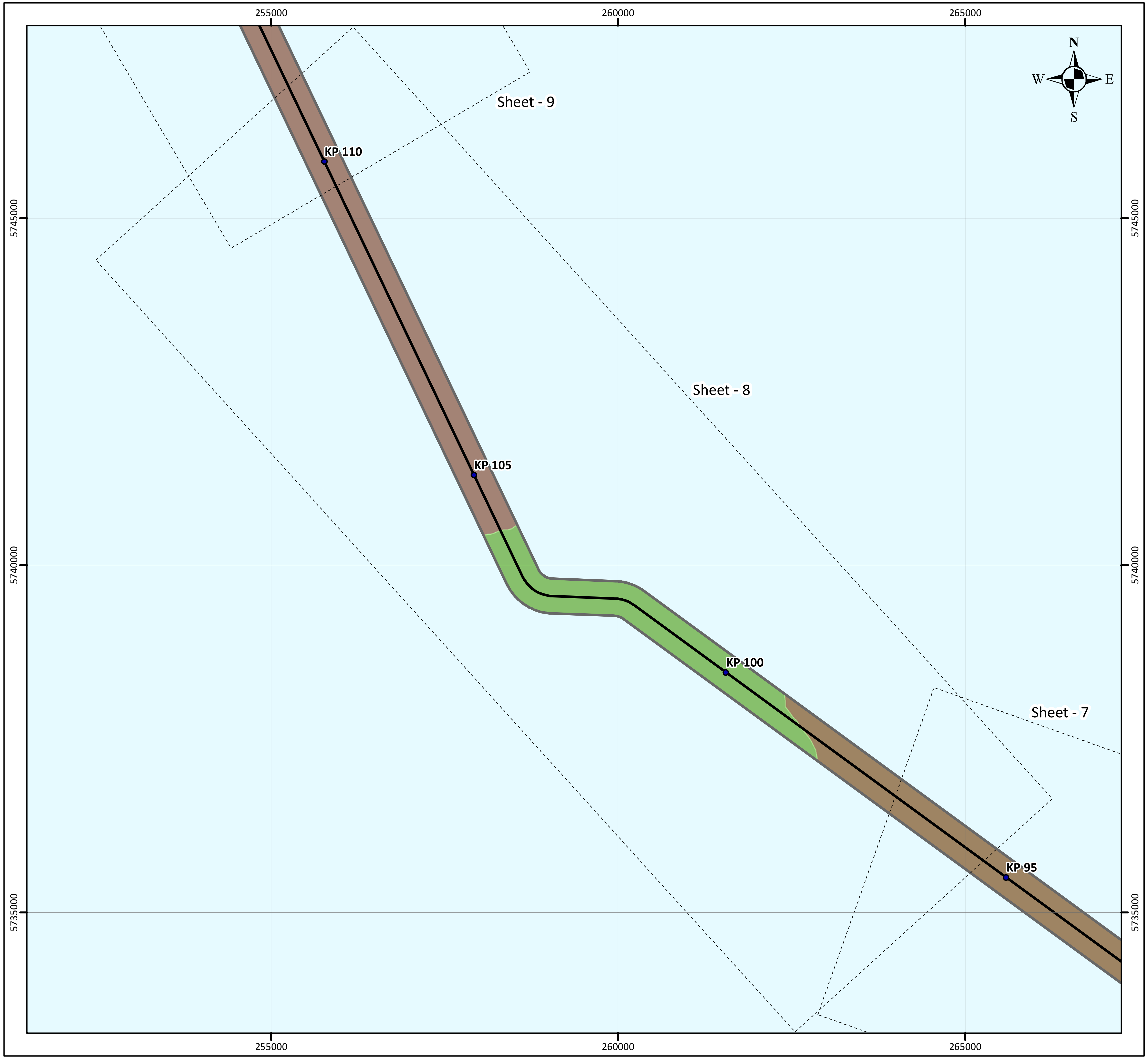
- A5.242
- A5.25
- A5.251



Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 8

Drawing No: P1975-HAB-003	A

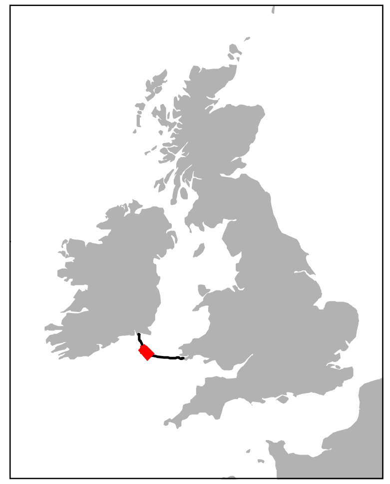
Legend

- Greenlink Route Centreline (Indicative)
- Irish Offshore

MMT Survey

EUNIS Classification

- A5.251
- A5.252
- A5.272

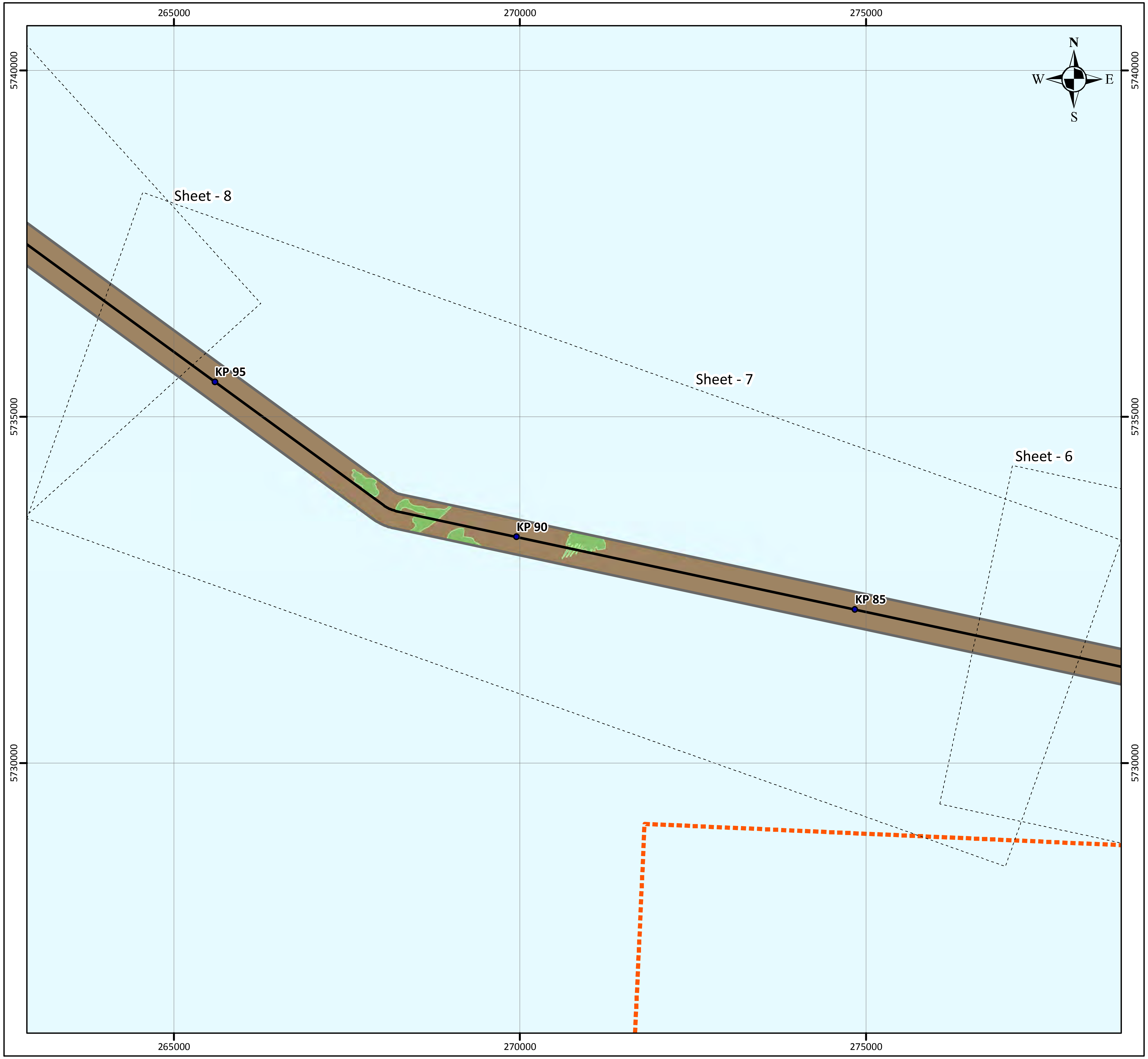


NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS
Survey Data - Sheet 7

Drawing No: P1975-HAB-003	A

Legend

- Greenlink Route Centreline (Indicative)
- Irish Offshore
- Median Line

MMT Survey

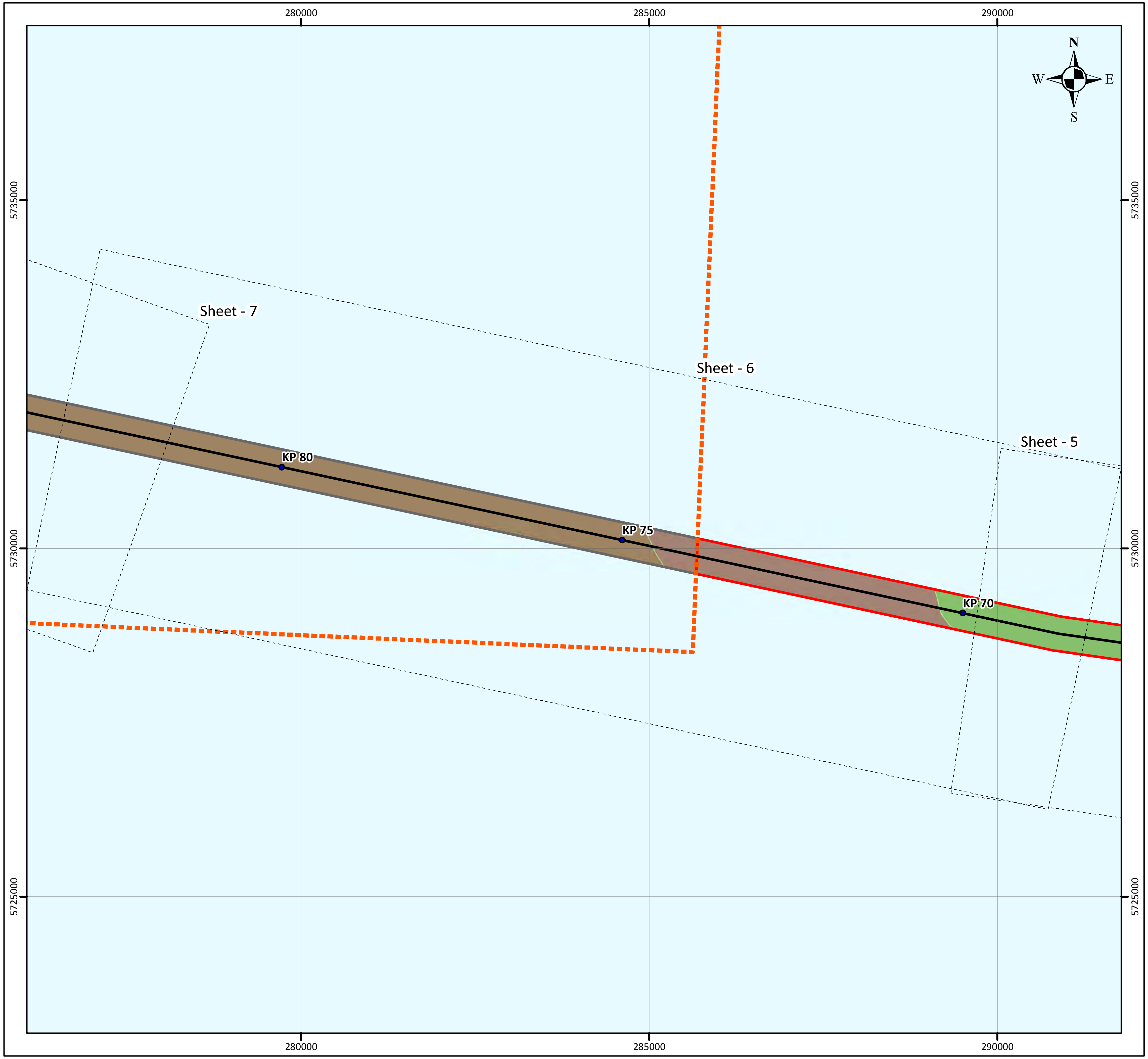
EUNIS Classification

- A5.252
- A5.272

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

BENTHIC HABITATS

Survey Data - Sheet 6

Drawing No: P1975-HAB-003	A

Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development
- Irish Offshore
- Median Line

MMT Survey

EUNIS Classification

- A5.251
- A5.252
- A5.272

NOTE: Not to be used for Navigation

Date	Monday, April 8, 2019 12:40:35
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-003.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km

7.3.4 Campile Estuary ecology and habitats

The Campile River at Dunbrody Bridge is tidal, with regular fluctuations in salinity and turbidity, and in the rate and direction of water flow. This section of the Campile River is part of the River Barrow and River Nore SAC. The shoreline habitat is classified as upper salt marsh habitat that has developed along the Campile River Channel (Figure 7-12). This upper section of the river is subject to less frequent and less prolonged inundation by the sea and, as a result, is not as saline in character as lower sections of the river.

Figure 7-12 Photographs 1 and 2 showing the proposed crossing area of the Campile River, with associated habitats, west of Dunbrody Bridge and north of the railway line.

The river channel has been considerably modified over time with the development of embankments along the southern bank of the river to the west of Dunbrody Bridge. The river channel embankments were created on both sides of the river banks to allow for the reclamation of intertidal habitats and thus to create farmland.

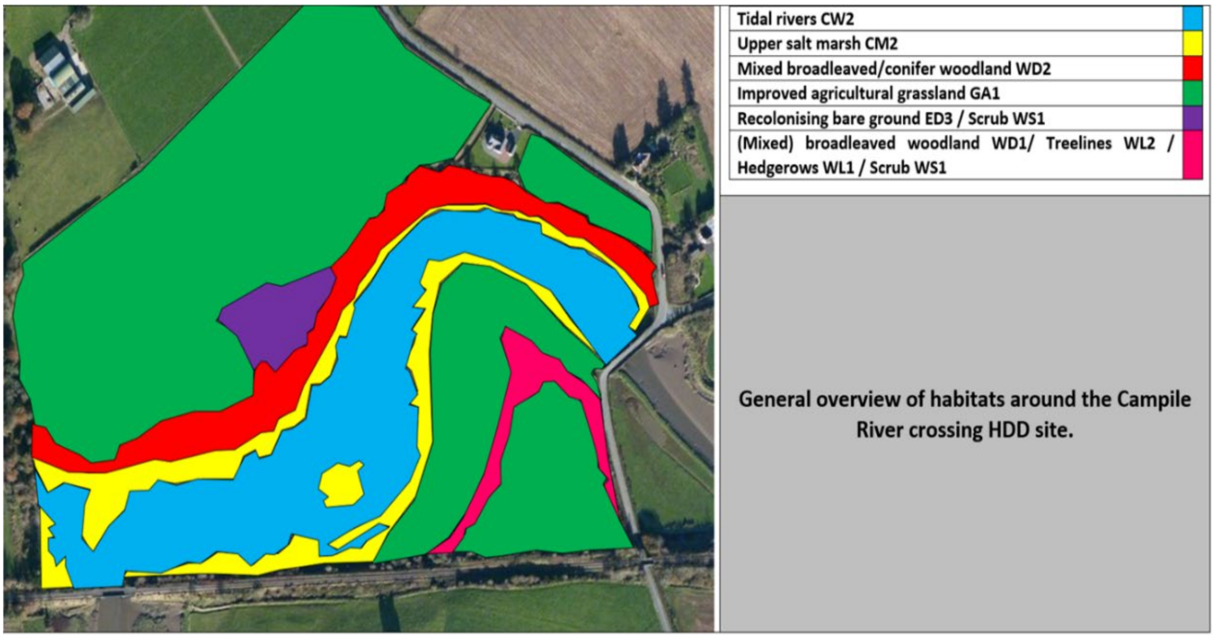
The embankment along the southern bank of the river to the west of Dunbrody Bridge separates the Campile River from an area of improved, heavily grazed agricultural grassland. The embankment itself, while showing some signs of grazing, is dominated by a mix of species including Sea Couch (*Elytrigia atherica*), False Oat-grass (*Arrhenatherum elatius*), Nettle (*Urtica dioica*), Bindweed (*Calystegia spp.*) and patches of Bramble (*Rubus spp.)*.

The section of the Campile River to the west of the Dunbrody Bridge is dominated by mudflat habitat which is exposed during periods of low tide. However, found scattered within these areas of consolidated mud and along the river bank are areas of upper salt marsh habitat. Floral composition varies. Common Cord-grass (*Spartina anglica*) has become abundant in places which can cause habitat loss and degradation. Other species noted include Sea Couch, Sea Club-rush (*Bolboschoenus maritimus*), Creeping Bent (*Agrostis stolonifera*), Sea Aster (*Aster tripolium*), Orache (*Atriplex spp.*) and Sea Plantain (*Plantago maritima*). There is some evidence of grazing by cattle within this habitat.

Situated to the north of this section of the Campile River, is a band of mixed broadleaved/conifer woodland. Species noted include Ash (*Fraxinus excelsior*), Oak (*Quercus spp.*), Birch (*Betula spp.*), Scots Pine (*Pinus sylvestris*), Sycamore (*Acer pseudoplatanus*) and Hawthorn (*Crataegus monogyna*). The high-risk invasive species Rhododendron (*Rhododendron ponticum*) was recorded growing within the understory of the woodland habitat at various locations.

Figure 7-13 presents the habitats identified at the Campile Estuary.

Figure 7-13 General overview of habitats west of Dunbrody Bridge



7.3.5 Protected species and species of conservation importance

7.3.5.1 Intertidal

Aggregations of honeycomb worm (*Sabellaria alveolata*) tubes and rockpools were ubiquitous across the site. Significant portions of the lower shore fucoid (brown seaweed) dominated rock found in the southern end of the survey area was colonised by low lying veneers of *S. alveolata* tube aggregations. Discrete clumps were also noted on the vertical faces of the sand-filled gullies formed by the rocky outcrops along the majority of the survey area. Given their low-lying nature (< 2 cm) and limited extent, these aggregations were not thought to be representative of the larger reef structures that are afforded protection as Annex I biogenic reef habitats under the EC Habitats Directive. However, the rock outcrops themselves do fall under the category of Annex I bedrock reef.

7.3.5.2 Subtidal

The cable route survey identified the following EC Habitats Directive listed Annex I habitats within the Proposed Development:

- Bedrock reef (1170)
- Large shallow inlets and bays (1160)

Both habitats are designating features of the Hook Head SAC; in which the Proposed Development lies between the landfall at Baginbun Beach, KP 159.267 to KP151.258.

Large shallow inlets and bays (1160):
Large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. Several of these habitat types (1140 Mudflats and sandflats not covered by sea water at low tide, 1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs) are listed as Annex I habitats in their own right.

Large shallow inlets and bays are large indentations of the coast, generally more sheltered from wave action than the open coast. They are relatively shallow (with water less than 30m over most of the area), and in contrast to 1130 estuaries, generally have much lower freshwater influence (JNCC 2019).

Figures 7-15 and 7-16 (P1975-HAB-004 Sheet 11 and Sheet 12) show areas along the Proposed Development which are classified as part of the habitat 'large shallow inlets and bays'.

Bedrock reef (1170):
The EC Habitats Directive habitat 1170 Reefs is described as "*Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the sea floor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animals species including concretions, encrustations and corallogenic concretions.*" (European Commission 2013)

The sub-type 'bedrock reef' occurs where the bedrock arises from the surrounding seabed creating a habitat that is colonised by many different marine animals and plants (JNCC 2014); it is a type of rocky reef. Rocky reefs can be very variable in terms of both their structure and the communities that they support. They provide a home to many species such as corals, sponges and sea squirts as well as giving shelter to fish and crustaceans such as lobsters and crabs.

Bedrock outcrops were identified in the geophysical data within the Proposed Development. These outcrops had been identified during route development and the indicative cable centreline follows a sand channel between the Bedrock reef.

Photo transects were performed across the corridor at three locations (DDV_T01 at KP158.318, DDV_T02 at KP156.911 and DDV_T03 at KP 156.136) to try to visualise the bedrock reef. However, due to poor visibility from suspended sediments, no habitats or associated fauna was recorded from transects DDV_T01 and DDV_T03. Transect DDV_T02 showed kelp on bedrock (Figure 7-14). All outcropping bedrock shallower than 20m, was classified to A3.11 - kelp with cushion fauna and/or foliose red seaweeds.

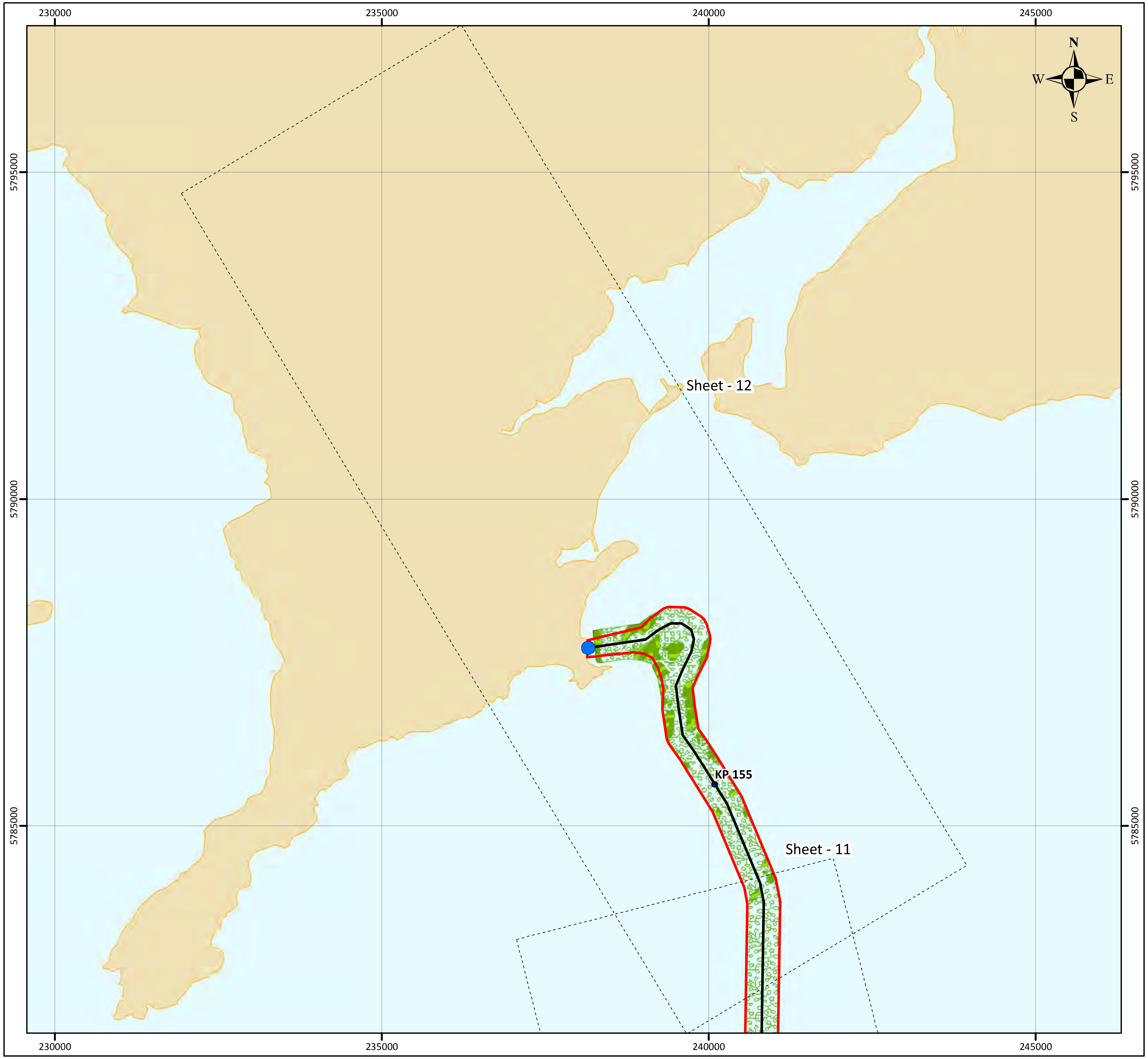
The reef habitats found in Hook Head SAC are bedrock and stony reefs of three community types: exposed to moderately exposed intertidal reef community complex, echinoderm and sponge dominated community complex, and laminaria dominated community (NPWS 2014). None of the invertebrate species listed in the Natura 2000 standard data form for Hook Head were identified in the grab samples (MMT 2019).

Areas of Laminaria sp. was identified on outcropping bedrock within the Irish EEZ.

Figure 7-15 and 7-16 (P1975-HAB-004 Sheet 12 and Sheet 11) shows areas within the Proposed Development classified as bedrock reef.

The extent of Annex I Reef habitat within the Proposed Development has been calculated as 5.33km^2; of which 4.16km^2 is within the Hook Head SAC. However, it is evident from INFOMAR bathymetry data and NPWS habitat maps for Hook Head SAC that exposed bedrock covers a greater extent, in the wider region. The extent of Reef protected by the Hook Head SAC, as measured from the NPWS habitat maps, is 105.34km^2. When compared, the habitat maps and Greenlink cable route survey data generally showed a good level of alignment; although as the Greenlink cable route survey is of a higher resolution, local small scale differences were identified.

Figure 7-14 Photograph from DDV_T02_001 showing Annex I (1170) – Bedrock reefs with the habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds



GREENLINK INTERCONNECTOR

ANNEX I HABITATS

Survey Data - Sheet 12

Drawing No: P1975-HAB-004	A

Legend

Landfall

- Baginbun Beach
- Greenlink Route Centreline (Indicative)
- Proposed Development

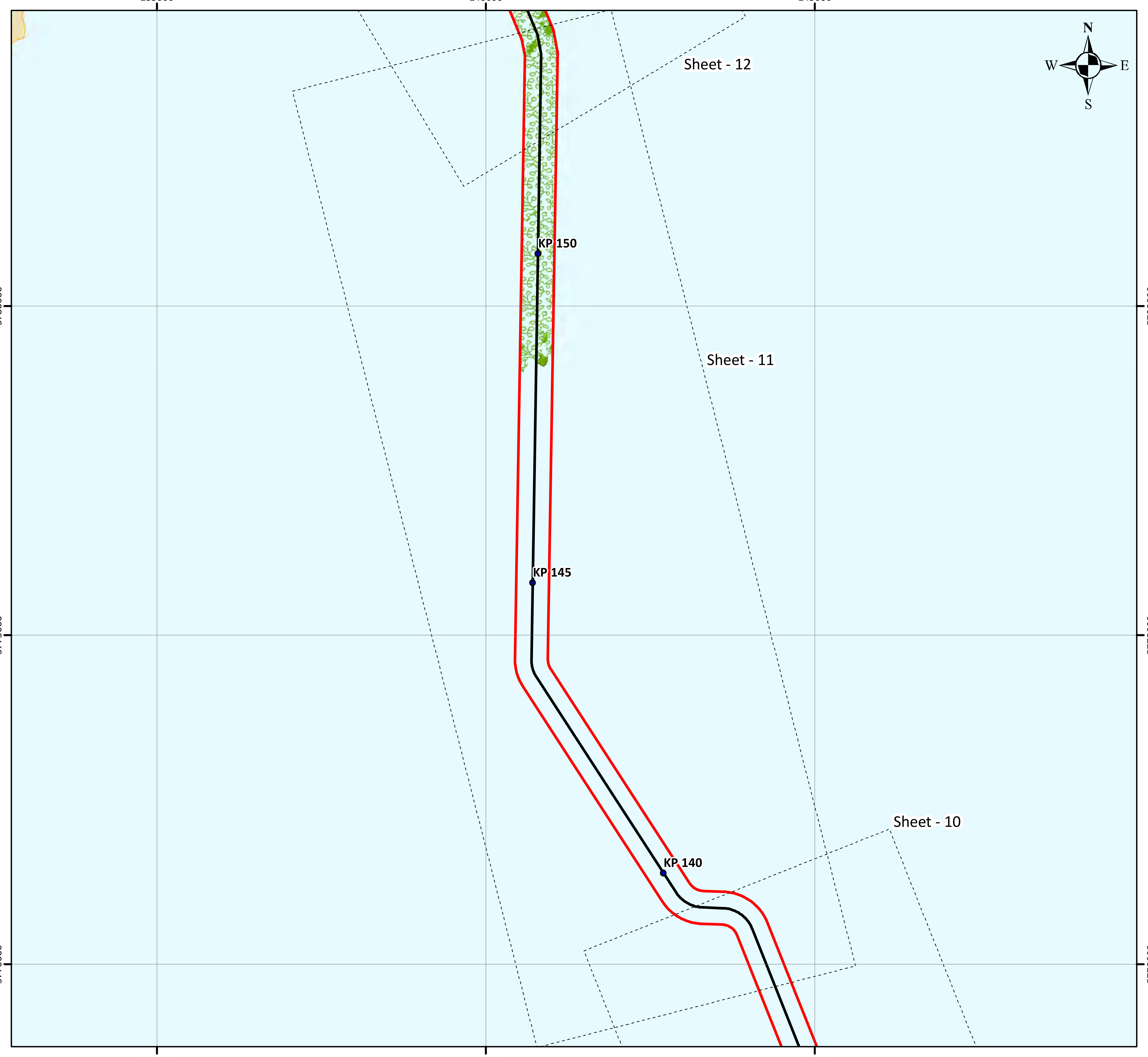
Annex I Habitat Classification

- Large Shallow Inlets/Bay
- Bedrock Reef

Date	Monday, April 8, 2019 12:43:10
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km



GREENLINK INTERCONNECTOR

ANNEX I HABITATS
Survey Data - Sheet 11

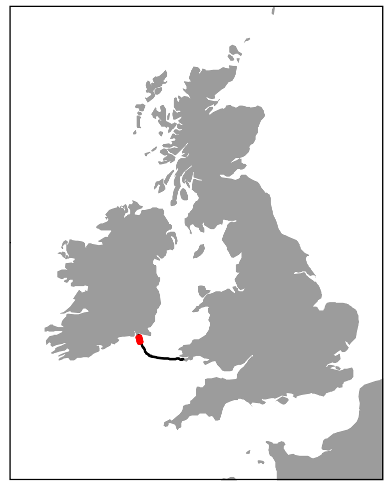
Drawing No: P1975-HAB-004	A

Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development

Annex I Habitat Classification

- Large Shallow Inlets/Bay
- Bedrock Reef



Date	Monday, April 8, 2019 12:43:10
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	DCCAE; UKHO; CDA; OSOD; OSI; MMT; Greenlink
File Reference	J:\P1975\Mxd\06_HAB\ P1975-HAB-004.mxd
Created By	Chris Goode
Reviewed By	Emma Langley
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 0.5 1 1.5 2 km

7.3.5.3 Campile Estuary

Annex I habitats currently listed as qualifying interest features for the River Barrow and River Nore SAC include H1310 Salicornia and other annuals colonizing mud and sand; H1330 Atlantic salt meadow (*Glauco-Puccinellietalia maritimae*); and H1410 Mediterranean salt meadows (*Juncetalia maritimi*).

The upper saltmarsh (CM2) identified in Figure 7-13 is part of the Dunbrody Abbey saltmarsh, one of four Saltmarsh inventory sites found in the River Barrow estuary. The Dunbrody Saltmarsh has been mapped as covering 0.425km^2 (41.465 hectares). Of this area Spartina swards cover approximately 0.01km^2 (1.208 hectares) and other saltmarsh (CM2) covers approximately 0.039 km^2 (3.928 hectares) (NPWS 2011a).

7.3.6 Natural evolution of the baseline

It is expected that in the short-term benthic habitats and communities will be subject to typical natural influences and anthropogenic pressures that will alter their range and composition such as storm events and hydroclimatic variability (DCCAE 2015). Longer term climate change impacts such as the increase in ocean temperatures have the potential to cause species at the southern limit of their range to shift their distribution northwards to remain in cooler waters. An increase in the pH of the seas as a result of climate change could result in a reduction in bivalve species such as horse mussels, with increasing acidity producing an increased metabolic cost for shell formation (Ventura 2018). Some estimates predict that horse mussel beds will have declined significantly by 2050, with complete population loss occurring by 2100 (MCCIP 2050).

7.4 Potential Pressure Identification and Zone of Influence

A scoping exercise undertaken to inform the content of the EIA has excluded the following pressures from further consideration in this topic Chapter. Explanation for the exclusion is provided in Chapter 5, Table 5-2:

- Hydrocarbon and PAH contamination;
- Temperature changes – local;
- Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features) – intertidal species only; and
- Introduction or spread of non-indigenous species.

The pressures listed in Table 7-4 will be assessed further. For each pressure the assessment considered the different aspects of the project during installation, operation (including repair & maintenance) and decommissioning. In order to evaluate the most significant effects, the largest zone of influence from these aspects was selected. The zones of influence are presented in Table 7-4.

Table 7-4 Pressure identification and zone of influence – intertidal, benthic and estuarine ecology

<table>
<tr><th>Project Phase</th><th>Project Activity</th><th>Aspect</th><th>Potential Pressure</th><th>Receptor</th><th>Zone of Influence</th></tr>
<tr><td>Installation</td><td>Campile Estuary</td><td>Campile Estuary HDD underneath the riverbed</td><td rowspan="4">Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion</td><td>Estuarine species and habitats</td><td>No effect</td></tr>
<tr><td>Installation</td><td>Cable burial</td><td rowspan="3">Pre lay grapnel run
Cable trenching (ploughing and jet trenching)</td><td rowspan="3">Subtidal species and habitats</td><td rowspan="3">15m</td></tr>
<tr><td>Operation</td><td>Cable repair and maintenance</td></tr>
<tr><td>Decommissioning</td><td>Cable removal</td></tr>
<tr><td rowspan="2">Installation</td><td rowspan="2">Cable burial</td><td>Cable trenching (ploughing and jet trenching)</td><td rowspan="2">Siltation rate changes, including smothering (depth of vertical sediment overburden)</td><td rowspan="2">Subtidal species and habitats</td><td rowspan="2">40m*</td></tr>
<tr><td>External cable protection</td></tr>
<tr><td rowspan="2">Installation</td><td>HDD exit points</td><td rowspan="2">External cable protection</td><td rowspan="2">Physical change (to another seabed type)</td><td rowspan="2">Subtidal species and habitats</td><td>208m^2</td></tr>
<tr><td>Irish Offshore third-party asset crossings</td><td>4 discrete locations in Irish Offshore each covering 1009m^2.
Overall 4036m^2</td></tr>
<tr><td rowspan="2">Operation</td><td rowspan="2">Operation of cables</td><td rowspan="2">Emission of EMF</td><td rowspan="2">Electromagnetic changes</td><td>Estuarine species</td><td rowspan="2">Distance at which EMF attenuates to background levels
12m at HDD exit point for unbundled cables
2m for remainder of route where cables are bundled</td></tr>
<tr><td>Subtidal species</td></tr>
<tr><td colspan="6">* Discussed in Section 7.6.3</td></tr>
</table>

7.5 *Embedded Mitigation*

The project description, Chapter 4, provides the design. This includes mitigation measures which form part of the design and are therefore an inherent part of the Proposed Development and Campile Estuary and comprise embedded or primary mitigation. The embedded mitigation relevant to intertidal, benthic and estuarine ecology is provided in Table 7-5 below. When undertaking the EIA, it is assumed that these measures will be complied with; either as a matter of best practice or to ensure compliance with statute.

Table 7-5 Embedded mitigation

ID	Embedded mitigation
EM6	Ballast water discharges from Project vessels will be managed under the International Convention for the Control and Management of Ships' Ballast Water and Sediments standard.
EM8	The latest guidance from the GB non-native species secretariat (2015) will be followed and a Biosecurity Plan produced pre-installation.
EM13	HDD will be used for the cable landfalls to avoid disturbance of sensitive habitats (e.g. intertidal reef habitat) and disruption on beaches.
EM14	Route engineering was undertaken during the marine survey to avoid sensitive habitats where possible or to reduce the distance the submarine cable corridor crosses a sensitive feature.
EM15	Submarine cables will be bundled together, which reduces which reduces the seabed footprint of installation activities and the electromagnetic field generated during operation, thus minimising any potential compass deviation effects.
EM17	Deployment of anchors/anchor chains on the seabed will be kept to a minimum in order to reduce disturbance to seabed.

7.6 Significance Assessment

7.6.1 Summary of assessment

Table 7-6 presents the summary of the impact assessment conducted on the Proposed Development and Campile Estuary. Sections 7.6.2 to 7.6.5 provide the justification for the conclusions. Where the assessment concluded the effects are significant, Project Specific Mitigation has been proposed and is described in Section 7.7. Where there is potential for residual effects this is discussed further in Section 7.8.

Table 7-6 Impact assessment summary – intertidal, benthic and estuarine ecology

Determination of potential effect						Impact assessment			Consideration of mitigation	Residual effect assessment		
Section	Project Phase	Aspect	Embedded mitigation	Potential Pressure	Receptor	Magnitude	Sensitivity	Significance	Project Specific Mitigation	Magnitude	Sensitivity	Significance of Residual Effect
7.6.2	Campile Estuary (Installation)	HDD under the riverbed	-	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Estuarine species	-	-	No effect	-	-	-	-
	Installation Operation (Repair & Maintenance) Decommissioning	Pre lay grapnel run. Cable trenching (ploughing and jet trenching) Cable removal	EM13, EM14, EM15, EM17		Habitats A5.24, A5.242, A5.25, A5.251, A5.252, A5.44	Low	Low	Slight	-	-	-	-
					Annex I reef habitat (A3.11)	Medium	High	Significant	PS2, PS3	-	-	No effect
					A5.272, A5.14	Low	Medium	Slight	-	-	-	-
7.6.3	Installation Operation (Repair & Maintenance) Decommissioning	Pre lay grapnel run. Cable trenching (ploughing and jet trenching) Cable removal	EM14, EM15, EM17	Siltation rate changes, including smothering (depth of vertical sediment overburden)	Subtidal species and habitats	Negligible	Low	Imperceptible	-	-	-	-
7.6.4	Installation	External cable protection	EM15	Permanent change (to another seabed type)	Subtidal habitats	Low	Medium	Slight	PS4	Low	Medium	Slight
7.6.5	Operation	Emission of EMF	-	Electromagnetic changes	Estuarine species	-	-	No effect	-	-	-	-
			EM15		Benthic species	Low	Low	Slight	-	-	-	-

7.6.2 Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion (change to seabed features)

7.6.2.1 Installation

Intertidal species and habitats

The design being assessed includes no intrusive works within the intertidal area i.e. between MHWS and LWM; embedded mitigation EM16. Therefore, there will be **No Effect** on intertidal species or habitats.

Subtidal species and habitats

The seabed within the direct zone of influence of the installation (15m – equivalent to the widest footprint of a cable trenching machine) will be temporarily disturbed by seabed preparation and cable laying operations e.g. pre-lay grapnel run, jet-trenching or plough trenching. The cable trench within this footprint will be 1m. Habitats and species within the zone of influence will either be smothered by temporarily displaced sediments (i.e. before sediment is returned to the trench),or compacted by the installation machines.

It is likely that a high proportion of the benthic invertebrates within the width of the plough/trench footprint, will be susceptible to mortality, injury or displacement as a result of coming into contact with the route clearance grapnel or cable installation machinery. This is more likely to affect less mobile species such as echinoderms and polychaetes. Activities causing displacement and injury to infaunal species could also result in increased predation resulting from exposure of individuals.

Most habitats in the Proposed Development comprise of sandy habitats with an infaunal community. Using information provided on the Marine Life Information Network (MarLIN), Table 7-7 presents an assessment of the sensitivity of habitats to the pressure.

Table 7-7 Sensitivity of habitats to the pressure 'Penetration and/or disturbance of the substrate below the seabed'

EUNIS habitat code	Resistance	Resilience	Sensitivity	Confidence *			
				Q	A	C	Overall
A3.11 - Kelp with cushion fauna and/or foliose red seaweeds	Low	Medium	Medium	H	H	H	High
A5.14 Circalittoral coarse sediment	Medium	Medium	Medium	L	L	L	Low
A5.24 - Infralittoral muddy sand	Medium	High	Low	M	M	M	Medium
A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	Medium	High	Low	H	H	M	High - medium

EUNIS habitat code	Resistance	Resilience	Sensitivity	Confidence *			
				Q	A	C	Overall
A5.25 - Circalittoral fine sand	Medium	High	Low	H	H	M	High - medium
A5.251 - Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand	Medium	High	Low	H	H	M	High - medium
A5.252 - *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	Medium	High	Low	H	H	M	High - medium
A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand	Low	Medium	Medium	H	M	M	Medium - high
A5.44 - Circalittoral mixed sediments	Low	Low	High	H	H	M	High - medium
Notes * specific to sensitivity Italics & grey = Assessment based on sublevel habitat assessments Q = Quality of Evidence; A = Applicability of Evidence; C = Degree of concordance (agreement between studies); L = Low; M = Medium; H = High							

The discussion below has been split into two sections; assessment of the effects on subtidal habitats (including Annex I habitat 'Large shallow inlets and bays') ; and an assessment of effects on Habitat A3.11 (including Annex I 'Bedrock reef'). The Annex I habitat 'Large shallow inlets and bays' are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. Therefore, the assessment undertaken on subtidal habitats is directly applicable to this habitat type.

Subtidal habitats (including Annex I habitat 'Large shallow inlets and bays')

Table 7-7 identifies that the majority of habitats present within the Proposed Development and Irish Offshore have been classified as having low to medium sensitivity to the pressure; with the exception of A5.44 Circalittoral mixed sediments.

The assessment for A5.44 is based on the EUNIS sub-level habitat A5.442 - Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment, as this is the only EUNIS sub-level habitat that has been assessed by MarLIN. The two featured species of the habitat are particularly sensitive to activities which cause abrasion and disturbance; *Cerianthus lloydii* is a tube-dwelling anemone, whilst *Modiolus modiolus* (blue mussel) are large, sessile and shallowly buried individuals unable to escape from activities which penetrate the seabed. The habitat A5.44 was identified within the Hook Head SAC between KP156 and KP158. It was sampled by one grab sample (S01). The grab sample consisted mainly of sand (60%) and was classified as gravelly muddy sand. The infaunal analysis showed a small sample with regards to abundance and diversity which was primarily characterised by crustaceans and polychaetes.

The species identified in the grab included the polychaetes *Sclerocheilus*, *Scolelepis korsuni*, *Parexogone hebes*, *Magelona johnstoni*, and *Heteroclymene robusta*; and the echinoderm *Echinocyamus pusillus*. The low abundance and diversity from the grab, suggests that the sensitivity category of high is over conservative for the habitat identified. Given the species identified, which are not as sensitive to abrasion as *Modiolus modiolus* and *Cerianthus lloydii*, and the low abundance and diversity confirmed by the grab sample, the sensitivity has been assessed as low in the EIA.

The sandy habitats identified in the Proposed Development are characteristic of moderately strong tidal currents, and given the dominance of sand and coarse sediments, can be viewed as adaptable to physical disturbance. Many infaunal species may live at depths where they will be protected from surface disturbance and in areas where direct loss occurs, it is likely that adjacent areas will act to replenish communities rapidly as most infaunal species are mobile and the zone of influence is narrow. Bivalves and gastropods are likely to take longer than polychaetes to re-colonise areas but even considering this it is unlikely to exceed months (MarLIN 2016).

The zone of influence of the installation (15m wide) represents a very small area when compared to the area encompassed by the Proposed Development and the extent of habitats in the wider region. Embedded mitigation, EM15 supports this by ensuring that the cables share a trench, reducing the seabed footprint of installation. The temporary disturbance will not change the physical characteristics of the seabed, meaning that once installation activities have ceased the seabed will still be suitable for recolonization from the surrounding area. Habitats will be disturbed twice by two separate activities; cable route clearance and cable installation. The latter activity, cable installation will be the more significant of the two and will be a one-off event that will not be repeated. Taking this into consideration, the magnitude of the effect has been assessed as low for all habitats.

The overall significance of the effect on all subtidal habitats identified with the Proposed Development and Irish Offshore has been assessed as **Slight** and is **Not Significant**.

Habitat A3.11 (including Annex I Bedrock Reef)

Areas defined as EUNIS habitat A3.11 have also been classified as ‘Annex I Bedrock Reef’. The extent of EUNIS habitat A3.11 and therefore Annex I Reef habitat within the Proposed Development has been calculated as 5.33km^2; of which 4.16km^2 is within the Hook Head SAC.

MarLIN does not provide a sensitivity assessment specifically for habitat ‘A3.11 - Kelp with cushion fauna and/or foliose red seaweeds’ for the pressure penetration and/or disturbance. The assessment presented in Table 7-6 is based on habitat ‘A3.113 - *Laminaria hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed infralittoral rock’ and the pressure abrasion. The supporting evidence for the assessment, based on studies following commercial *Laminaria hyperborea* trawling, suggests that beds of mature *Laminaria hyperborea* can regenerate from disturbance within a period of 1-6 years and the associated community within 7-10 years (Stamp and Hiscock 2015). As a *Laminaria* dominated community is a qualifying feature of the Hook Head SAC, this assessment is thought to be appropriate for the habitat A3.11 found within the Proposed Development.

Bedrock reef is a qualifying feature of the Hook Head SAC and is of high environmental value as it supports a diverse range of algae, invertebrates and fish species. The EIA has therefore concluded that the sensitivity of the habitat should be increased from medium to high in recognition that the habitat is a key contributor to the overall biodiversity of the SAC.

The conservation objectives for the site state that "*Those communities that are key contributors to overall biodiversity at a site by virtue of their structure and/or function (keystone communities) should be afforded the highest degree of protection and any significant anthropogenic disturbance should be avoided*" (NPWS 2011b).

The presence and location of the Annex I habitat offshore was taken into consideration during the design (routeing) of the Proposed Development. INFOMAR bathymetry data and NPWS habitat maps were used to identify a suitable cable route through the Hook Head SAC that avoids crossing the Annex I habitat (embedded mitigation EM14). Route engineering was undertaken during the marine survey to investigate options to further avoid outcropping rock features. This has led to the selection of the final route, shown as the indicative centreline within the Proposed Development. The design being assessed is therefore an installation corridor that avoids crossing the Annex I bedrock reef habitat offshore. The channel between the mapped Annex I habitat features is sufficiently wide to allow installation within the sandy sediments.

Bedrock reef has also been identified in the nearshore area; extending out from the intertidal zone. The intention is to HDD under the beach to an exit point in the nearshore area. During the EIA process consideration was given to whether it would be feasible for the HDD to exit within this fringing Bedrock Reef (which reduces the length of the HDD).

GIL have consulted with NPWS throughout the design of the Proposed Development regarding routeing a cable through the Hook Head SAC. NPWS have been clear from the start that the use of external cable protection on Qualifying Interest Reef habitat has the potential to have a likely significant effect on the habitat. Although there is scope that external cable protection will be colonised by a similar reef habitat, potentially reducing the significance of the effect, other factors were taken into consideration when considering the environmental implications of the HDD exit points. These included:

- Cable trenching in outcropping rock would require cutting, which would have a narrow (1m wide) but permanent effect on the habitat. The magnitude of the effect was assessed as medium, which combined with the high sensitivity classification for the habitat (as discussed above) results in an effect that is **Significant.**
- In order to protect the cables in a rock cut trench, external cable protection would be required. A rock berm just below the low water mark on the fringing reef would modify wave patterns, which in turn will affect sediment transport along the beach.
- There would be a local scour concern with respect to the feature (current and wave driven).
- A rock berm would have a significant visual effect on the landscape values of the beach. As a popular public beach, with historic connections, a negative change in the recreational value of the beach would be considered significant.

The EIA process concluded that the significance of the effects on the habitat were likely to be Significant and that there was potential for significant effects on other receptors that an engineering alternative should be investigated. It was therefore recommended that trenching across the fringing Bedrock Reef should be excluded from the project description.

The design taken forward in the project description is that cable trenching will not be undertaken on any of the Bedrock reef habitat within the Proposed Development. This removes the pressure-receptor pathway and there will be **No Effect** on the habitat.

Project Specific Mitigation, presented in Section 7.7, has been proposed to ensure it is clear that this EIAR commits to no intrusive works on Annex I Bedrock Reef Habitat.

This potential effect is also discussed within the Greenlink Natura Impact Statement (NIS). The NIS concluded that the Proposed Development will not adversely affect the integrity of the Hook Head SAC either alone or in combination with other plans and projects.

Estuarine species and habitats

The works associated with drilling the boreholes under the Campile Estuary will be set-back above MHWS. The boreholes will be >10m below the riverbed. Therefore, there will be **No Effect** on estuarine species or habitats.

The compound for the HDD site will be located in common agricultural habitats of low ecological value. The effect on this habitat has been assessed in the Irish Onshore EIAR which concluded no significant effect.

7.6.2.2 Operation (including maintenance and repair)

No disturbance or habitat loss will occur from the operating cables. Effects during any unforeseen repair and maintenance works will be of a smaller magnitude when compared to cable installation. The assessment considered five discrete cable repairs during operation and concluded that the significance of the effect remains:

- **No effect** on estuarine habitats;
- **Slight** and is **Not Significant** for all subtidal habitats; and
- **Significant** for Annex I Bedrock Reef habitat.

7.6.2.3 Decommissioning

Two options will be considered at decommissioning; leaving the cables in-situ and removing them. If the cables are left in-situ there will be no effect on intertidal benthic and estuarine habitats and species during decommissioning. However, if the option to remove the cables (and any associated protection) is selected, this process would essentially be the same as installation activities but in reverse. Therefore, any effects that could arise due to the decommissioning phase of the Proposed Development will be of a comparable magnitude to those assessed above for cable installation and so the effect has been assessed

- **No Effect** on estuarine habitats;
- **Slight** and is **Not Significant** for all subtidal habitats; and
- **Significant** for Annex I Bedrock Reef habitat.

7.6.3 Siltation rate changes, including smothering (depth of vertical sediment overburden)

7.6.3.1 Installation

The area surrounding the cable trench is likely to be affected by the suspension and subsequent deposition of sediments as a result of installation activities. Jet trenching will cause a greater level of sediment suspension compared to the use of ploughing equipment.

The extent of suspension, dispersion and re-deposition is to a large extent a function of the type of sediment being disturbed as follows:

- Sand and gravel disturbed during the cable burial operations will settle back to the seabed very rapidly and the footprint is unlikely to extend any great distance from the cable route.
- Silts, clay and chalk particles will remain in suspension for a greater period of time and will be dispersed over a much greater distance, depending upon the strength of the tidal currents. However, the depth of deposition over such a large area is likely to be small.

Chapter 6 concluded that gravel will settle out of suspension rapidly (14 seconds), within 2m of the trench. Sand will settle out in 2 minutes within 19m of the trench but silt particles will be carried by currents up to 5.3km before settling out of suspension. Sand will form a thin layer on average 16mm thick over the 19m distance. However, as the silt particles are finer and travel further distances before settling the average thickness of deposition form the silt fraction will be less than 1mm thick. The zone of influence has therefore been based on the sand fraction and estimated as 40m wide, centred on the trench, to take account of tidal oscillation.

Dilution calculations indicate that the average suspended sediment concentration will reach 300mg/l within 100m of the trench; but will rapidly dissipate with distance and time.

Although modern equipment and installation techniques have reduced the re-suspension of sediment during cable trenching activities, remaining suspended sediment dispersed into the water column has the potential to affect sessile filter feeders and, once settled out, could potentially smother organisms within the deposition area. Suspended sediments can obstruct the filtration mechanisms of some benthic and pelagic species. For example, some types of worm and brittle stars can be affected through the clogging of gills or damage to feeding structures. Suspended sediments can also attach to fish eggs causing abnormalities or death. It can also affect the growth of the macrobenthos and may have a lethal effect on some species.

The magnitude of the effect will depend on the percentage of silt fraction and background levels (OSPAR 2012), whilst the sensitivity of receptors depends on a number of factors including the ambient levels of suspended particulate matter (SPM) and the degree of variation throughout the year. If the natural levels of SPM and the seasonal variation are high, then the significance of the effect is likely to be less (BERR 2008).

Chapter 6 provides available measurements of SPM for the Co.Wexford coastline as ranging between 5mg/l to 19mg/l. The Co.Wexford coastline experiences seasonal fluctuations in turbidity, related to storm conditions. This is evident from photographs taken during the benthic survey (October 2018) showing high suspended sediment loads in the water column; potentially greater than 100mg/l and up to 1000mg/l, although this was not measured and is based on comparison of the image with samples showing known concentrations of SPM.

The subtidal habitats identified within the Proposed Development are widely occurring and general sensitivity to smothering is low (MarLIN 2019). With respect to the Annex I Bedrock reef habitat, MarLIN (2019) classified a similar habitat (A3.113) as not sensitive and highly resilient to light changes in SPM concentrations. Subtidal habitats within the area experience these conditions annually as evident from the cable route survey photographs suggesting that an increase in SPM and subsequent deposition is unlikely to significantly effect habitats.

Increases in SPM concentrations will be brief (restricted to the immediate period when cable burial is taking place) and localised. Increases in SPM associated with the cable route clearance will be of a lower magnitude than those associated with cable burial. They will also be separated temporally. A brief change in water clarity, with associated deposition of suspended sediments will be experienced, but it is predicted that the change will be within the normal environmental variation experienced after storm conditions.

Based on the discussion above the magnitude of the effect has been assessed as negligible. No activities within the Proposed Development will culminate in a manner that causes the magnitude of the effect to increase. The sensitivity of subtidal habitats, including Annex I Bedrock reef has been assessed as low. The overall significance of the effect has been assessed as **Imperceptible** and is **Not Significant**.

The potential effect of this pressure on the Hook Head SAC has also been assessed within the Greenlink Marine NIS. The NIS concluded no potential for significant effects and that an Appropriate Assessment is not required for this pressure.

7.6.3.2 Operation (including maintenance and repair)

Effects during any unforeseen repair and maintenance works will be of a smaller magnitude when compared to cable installation. The assessment considered five discrete cable repairs during operation and concluded that the significance of the effect remains **Imperceptible** and is **Not Significant**.

7.6.3.3 Decommissioning

Two options will be considered at decommissioning; leaving the cables in-situ and removing them. If the cables are left in-situ there will be no effect on intertidal benthic and estuarine habitats and species during decommissioning. However, if the option to remove the cables (and any associated protection) is selected, this process would essentially be the same as installation activities but in reverse. Therefore, any effects that could arise due to the decommissioning phase of the Proposed Development will be of a comparable magnitude to those assessed above for cable installation and so the effect has been assessed as **Imperceptible** and is **Not Significant**.

7.6.4 Physical change (to another seabed type) – subtidal

7.6.4.1 Installation

The design being assessed is that as a contingency a very small quantity of external cable protection (20m x 5.2m by 0.7m high) will be used at both HDD exit points to protect the cables before they can be bundled together and trenched. The HDD exits points lie in the habitat A5.23 Infralittoral fine sand. External cable protection would consist of rock in the size range 2-22cm, which would represent a significant coarsening of the sediment, and a localised change in seabed type.

A Qualifying Interest of the Hook Head SAC is the habitat large shallow inlets and bays. The sand substrate between 3m and 15m water depth is part of the feature. The Natura 2000 form for the site (NATURA 2000 2018) records that the Qualifying Interest covers an area of 52.44km^2 (5243.8404 hectares). The footprint of the external cable protection within this habitat will cover 208m^2; equivalent to 0.0004% of the Qualifying Interest. This is a negligible reduction which will not adversely affect the conservation targets for the Qualifying Interest. This conclusion is supported by NPWS (2011) that "licensing of activities likely to cause continuous disturbance of each community type should not exceed an approximate area of 15%.".

External cable protection will also be used at crossing locations in the Irish Offshore. Where external cable protection is used the seabed habitat within the footprint of the berm will be lost and replaced with potentially harder substrate, changing the seabed type.

Within the Irish Offshore four third-party asset crossings are required with an estimated seabed footprint of 0.004km^2 (Section 4.7.4, Table 4-5). This footprint has been reduced through the implementation of embedded mitigation EM15, whereby the Greenlink cables will be bundled together.

The crossing locations lie outside of any protected sites. Table 4-5 identifies the crossings are located in the following EUNIS habitats:

- A5.272 - *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand: ESAT 1 crossing
- A5.242 - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand: SOLAS crossing; and
- A5.252 - *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand: Pan European Crossing 1 and Hibernia Seg D crossing.

The MarLIN sensitivity assessment concludes that for all three habitats the sensitivity to the pressure 'physical change (to another seabed type)' is high. This is based on the fact that *"The biotope is characterised by the sedimentary habitat (JNCC 2015), so a change to an artificial or rock substratum would alter the character of the biotope leading to reclassification and the loss of the sedimentary community including the characterizing bivalves, polychaetes and echinoderms that live buried within the sediment"* (Tillin 2016).

The EUSeaMap (EMODNet 2019) indicates that the habitats identified by the cable crossing survey are common within the Irish Sea and cover large areas of seabed. The sensitivity of the habitats has therefore been reduced to medium in the EIA as the habitats are not internationally, nationally or locally important and are not within a protected site.

Material used for rock berms is typically coarse gravel to cobbles. Therefore, external protection will result in a localised site-specific coarsening of sediments.

Post-construction monitoring of offshore windfarms has provided useful insight into the effects of a habitat change from sandy sediments to hard substrate. Case Studies on the Offshore Windfarm Egmond aan Zee, Prinses Amalia Wind Farm and Horns Rev Wind Farm found that the density of species on scour protection areas were high and the number of species observed increased with time. In addition, in many cases the number of rare species had also increased (Waardenburg et al 2017). Studies (Lindeboom et al 2011) at OWEZ identified 11-17 hard substratum benthos species on the rock material. At the Horns Rev windfarm the scour protection has been colonised by sea anemones and the soft coral *Alcyonium digitatum* (Langhamer 2012). Monitoring of the Nord Stream pipeline in Swedish waters showed that over a period of four years a general increase in epifauna was seen on the introduced hard substrate (pipeline and rock berms) (Nord Stream 2014).

Further studies (although limited) into the effects of artificial structures on adjacent soft sediments have provided contrasting results. Changes in localised community structure as a result of changes in sediment texture have previously been identified by Ambrose and Anderson (1990). Results showed reduced densities of some taxa near artificial structures which may have either resulted from increased predation as reef-associated fish move over sand to feed or changes in localised sediment composition creating a less suitable habitat for certain species. In contrast to this, Davis et al (1982) identified no measurable decrease in adjacent infauna densities at a distance of 4m from artificial structures over the two year period since their introduction (Pidduck et al 2017).

The colonisation of the hard substrate will be dependent on the passive transport of adult organisms or the availability of larvae from the surrounding region. However, in the examples provided above, the rock was introduced into areas of soft substrate and colonisation of the rock protection material has occurred. It can therefore be assumed that the external cable protection at the crossing locations will inevitably support the settlement of non-local hard bottom fauna that may not be representative of the surrounding benthos. Evidence suggests that effects on the local fauna in soft sediment areas will in most cases be very localised but long-term.

The external cable protection at the two HDD exit points, if required, will be within close proximity to existing Reef habitat; Reef is a maximum of 300m away from any potential HDD exit points. Colonisation of the external cable protection in these areas is more certain. This is supported by the cable route survey which shows the areas of bedrock separated from the main reef e.g. within the sediment channel, also support reef community.

The reef habitat in the area is classed as EUNIS habitat A3.11 – Kelp with cushion fauna and/or foliose red seaweeds. A study looking into the colonization of a newly created rocky shore in the Moray Firth found that limpets and barnacles were observed after 3-4 years (MarLIN 2019). A study by Hawkins & Southward (1992) (referenced in MarLIN 2019) found that, after the Torrey Canyon oil spill, it took between 10 and 15 years for the Fucus sp. to return to 'normal' levels of spatial and variation in cover on moderately exposed shores. This suggests colonisation would occur in the medium-term.

The external cable protection deposits could be viewed as artificial reef. The OSPAR Commission (2009) defines an artificial reef, as a 'submerged structure placed on the seabed deliberately, to mimic some characteristics of a natural reef. It could be partly exposed at some stages of the tide'. This places the external cable protection material outside the formal definition on the basis of purpose. However, almost all man-made structures placed on the seabed are rapidly and quickly colonised by marine organisms (Linley et al 2008). The effects of artificial reefs are ambiguous with Linley et al (2008) citing studies such as Ambrose and Anderson (1990) which have shown that some species of infauna were enhanced whilst others were depressed. It is therefore acknowledged that whilst external cable protection could enhance the productivity and biodiversity of the habitat, it will also represent a variation on the habitat that was previously there.

Whilst the use of external cable protection will lead to a slight reduction in the area of sand habitat it will also lead to a slight increase in reef habitat; with a potentially higher diversity of species.

Taking the above discussion into consideration, the magnitude of the effect has been assessed as low, given the small, localised zone of influence of the pressure in the context of the available habitat within the region.

The overall significance of the effect has been assessed as **Slight** and is **Not Significant**.

This potential effect has also been assessed within the Greenlink Marine NIS. Stage 1 Screening concluded a potential for significant effects on the Hook Head SAC and that Appropriate Assessment was required. The NIS concluded that the Proposed Development will not adversely affect the integrity of the Hook Head SAC either alone or in combination with other plans and projects.

As the HDD exit points lie within a Qualifying Interest habitat of the Hook Head SAC Project Specific Mitigation has been proposed in Section 7.8.

7.6.4.2 Operation (including maintenance and repair)

Effects during any unforeseen repair and maintenance works will be of a smaller magnitude when compared to cable installation. The assessment considered five discrete cable repairs during operation and concluded that the significance of the effect remains **Slight** and is **Not Significant**.

7.6.5 Electromagnetic changes

7.6.5.1 Operation

The Greenlink cables will be installed in direct contact with each other (bundled configuration, embedded mitigation EM15), with currents flowing in opposite directions. Magnetic (B) fields will emanate into the surrounding environment; although they will attenuate with distance (both horizontally and vertically). Movement through the B fields i.e. water currents or organisms swimming through, creates an induced electric (iE) field. The effect will be present along the Proposed Development.

The background geomagnetic field for the Celtic Sea is approximately 48.7 μT (Natural Resources Canada 2019), with the background iE field calculated as between 34.09 μV/m and 48.7 μV/m in Irish waters.

It has been calculated that the bundled Greenlink cables will generate B fields of 21μT directly over the cables reducing to natural background levels within 2m. The iE fields are estimated to be between 48.79 and 69.7 μV/m at 1m from the cables. No detectable change above background geomagnetic fields will be noticeable at 2m from the cables.

For a short distance in water depths of between 9m and 15m the cables will not be bundled as they exit the HDD point. In this area the iE fields will be slightly higher, up to 128.7μV/m at the seabed reducing to 63.7μV/m at 10m from the cable and natural background levels at 12m.

Estuarine species

The cables will be buried 10m below the river bed in HDD boreholes. As there will be no detectable change to background geomagnetic fields noticeable at distances greater than 2m from the cable, there is no pathway for an effect on estuarine species. The assessment concluded there will be **No Effect** on estuarine species.

Subtidal species

The effect of EMF on benthic species is largely unknown. There is little and contradicting evidence of interactions with anthropogenic sources of magnetic fields. As benthic communities are typified by sessile or low-mobility species, which are unlikely to navigate using magnetic fields and anomalies, these species, are less likely to be affected than more mobile species such as teleost fish or elasmobranchs, which are assessed in Chapter 8. The exception could be crustaceans, such as edible crabs (*Cancer pagurus)*, lobster (*Homarus gammarus)* and prawns (e.g. *Nephrops norvegicus*). The brown shrimp (*Crangon crangon*) has been recorded as being attracted to AC magnetic fields of the magnitude expected from submarine power cabling (ICES 2003). However, Bochert and Zettler (2004) found no effects of exposure to static B fields upon the same species, nor upon the round crab (*Rhithropanopeus harrisii*), an isopod (*Saduria entomon)* or the mussel (*Mytilus edulis*). Demonstrations of B fields ranging between 1-100μT delaying embryonic development in sea urchins (Zimmerman et al. 1990), and of high frequency AC EMF causing cell damage to barnacle larvae and interfering with their settlement (Leya et al. 1999), contrasts with anecdotal evidence of benthic invertebrates living directly upon DC electrodes (Nielson 1986) with no apparent effects (Swedpower 2003). The sensitivity of the receptor to EMF has been assessed as low.

A number of marine invertebrate species that inhabit the Proposed Development are magnetically sensitive, including important commercially targeted taxa such as lobster, crabs, shrimps, and molluscs. As discussed above, B and iE fields generated by the Proposed Development will attenuate to below background geomagnetic field levels within 2m of the cables where cables are bundled, and within 12m where unbundled cables exit the HDD ducts.

Potential effects will largely be negated by cable bundling and cable burial; burial to a depth of at least 0.6m will prevent most invertebrates (except deep borrowing species such as certain Crustacea and bivalve molluscs) encountering the strongest fields present on the cable surfaces. In addition, embedded mitigation EM15, bundling of the cables, also significantly reduces the magnitude of the effect. The magnitude of the effect has been assessed as low, as although it will be a long-term change, the alteration will be extremely localised, and the underlying character of the baseline will be similar to the pre-development situation.

The overall significance of the effect has been assessed as **Slight** and is **Not Significant.**

7.7 Project Specific Mitigation

In addition to the embedded mitigation outlined in Table 7-5, Table 7-8 presents measures that GIL is committed to adopting.

Table 7-8 Project specific mitigation – intertidal, benthic and estuarine ecology

ID	Project Specific Mitigation
PS2	Exclusion zones have been established around Annex I bedrock reef features; shown on Figure 7-18, Drawing P1975-INST-008). No intrusive works (e.g. cable installation, deposit of external cable protection material) will be undertaken within these exclusion zones.
PS3	There will be no intrusive works undertaken on Baginbun Beach between mean high water springs and the low water mark.
PS4	If the contingency external cable protection is used at the two HDD exits, then an environmental monitoring plan will be established to monitor colonisation of the external cable protection. The monitoring programme will be developed in consultation with NPWS. It is proposed that this be conducted using drop-down video transects. A control transect should be established on the adjacent Annex I reef to establish a baseline for community diversity. The length of the external cable protection will also be surveyed. Monitoring would be planned to coincide with the first two routine cable inspection surveys. It is expected that the first inspection survey will be undertaken within the first three years of installation, with a second survey undertaken within three years of the first survey. All footage will also be reviewed for the presence of invasive non-native species. The objectives of monitoring colonisation of the external cable protection will be to establish an evidence base to confirm (or otherwise) the conclusion that the deposition of the external protection material adds to the Reef habitat within the Hook head SAC.

7.8 Residual Effect

The assessment presented in Section 7.6 identified that one potential pressure could have a significant effect. The significance of the effect was therefore re-assessed taking into consideration the Project Specific Mitigation outlined in Section 7.7 to determine if a residual effect remains.

7.8.1 Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion

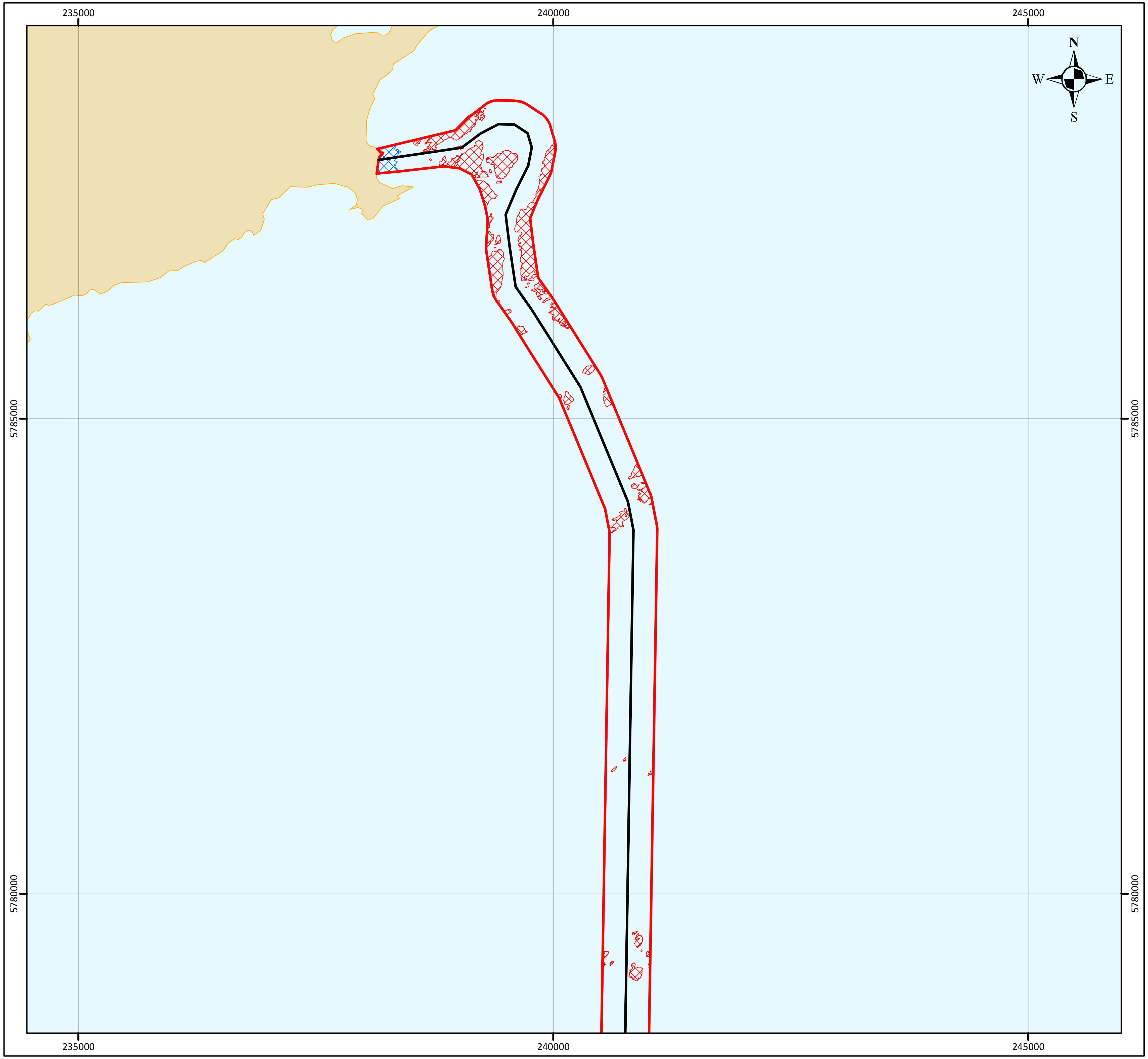
The assessment identified that Annex I Bedrock Reef (habitat A3.11) is highly sensitive to the pressure penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion. Activities that involve intrusive seabed works have been assessed as having a Significant effect on the habitat. The Proposed Development has been optimised to avoid the majority of the Annex I

Bedrock Reef habitat, by following a sand channel and prescribing an HDD exit points that exit within a sediment unit avoiding the Annex I Bedrock Reef in the nearshore area. Project Specific Mitigation in the form of exclusion zones (PS2) have been established around the habitat within the Proposed Development. GIL will ensure that the Installation Contractor adheres to these exclusions by ensuring the HDD exit points and final cable trench avoids the habitat. Implementation of the exclusion zones will result in the pressure pathway to the habitat being removed and the subsequent residual effect has been assessed as **No effect**.

7.8.2 Physical change (to another seabed type)

The EIA concluded that the pressure will not have a significant effect on the habitats present in the Proposed Development. However, as there is a contingency to use a small quantity of external cable protection at the HDD exit points, within the Hook Head SAC, Project Specific Mitigation PS3 has been proposed. PS3 seeks to reduce the footprint of the effect by requiring the Installation Contractor to seek alternative means of achieving the required depth of burial before the use of external cable protection. However, as it is not known whether alternatives will be available, the residual effect remains **Slight** and is **Not Significant**.

No further Project Specific Mitigation can be proposed that reduces the footprint, magnitude or sensitivity of the effect. Where external cable protection is used monitoring has been recommended (PS4). Although monitoring will not reduce the effect, the objective is to validate the conclusion of short-term effects. It is thought monitoring would be beneficial for the management of the Hook Head SAC. Validating the conclusions of the Greenlink Marine NIS will support the decision making for future applications.



GREENLINK INTERCONNECTOR

INSTALLATION

Annex I Habitat Exclusion Zones - ROI Route

Drawing No: P1975-INST-008	A

Legend

- Indicative Greenlink Route Centreline
- Proposed Development
- Annex I Habitat Exclusion Zone
- Trenching Exclusion Zone

NOTE: Not to be used for Navigation

Date	Monday, April 29, 2019 14:14:29
Projection	WGS_1984_UTM_Zone_30N
Spheroid	WGS_1984
Datum	D_WGS_1984
Data Source	OSI; MMT; ESRI; Greenlink
File Reference	J:\P1975\Mxd\15_INST\ P1975-INST-008.mxd
Created By	Chris Goode
Reviewed By	Chris Carroll
Approved By	Anna Farley

Co-financed by the European Union
Connecting Europe Facility

0 500 1,000 1,500 2,000 m

REFERENCES

1 Ambrose, R.F. and Anderson, T.W. (1990). Influence of an artificial reef on the surrounding infaunal community. Marine Biology, 107, 41-52

2 Ashley, M. (2016). Polychaetes in littoral fine sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/habitat/detail/1125 (Accessed April 2019)

3 Bochert, R. and Zettler, M.L. (2004). Long-term exposure of several marine benthic animals to static magnetic fields. Bioelectromagnetics 25: 498-502.

4 Bourma, S and Lengkeek, W. (2012). Benthic communities on hard substrates of the offshore wind farm Egmond aan Zee (OWEZ). [online] Available at: https://www.buwa.nl/fileadmin/buwa_upload/Bureau_Waardenburg_rapporten/BW_research_OWEZ_benthic_communities_-_compressed_file.pdf (Accessed April 2019)

5 Davies J, Baxter J, Bradley M, Connor D, Khan J, Murray E, Sanderson W, Turnbull C, Vincent M (2001) Marine Monitoring Handbook March 2001.

6 DCCAE (2015). Irish Offshore Strategic Environmental Assessment (IOSEA) 5 Environmental Report [Online]. Available at: www.dccae.gov.ie/en-ie/natural-resources/publications/Documents/6/IOSEA5EnvironmentalReport.pdf (Accessed June 2019)

7 Defra (2010) Charting Progress 2: The state of UK seas. Section 3.7 Suspended Particulate Matter and Turbidity. [online] Available at: https://webarchive.nationalarchives.gov.uk/20141203184415/http://chartingprogress.defra.gov.uk/feeder/Section_3.7_Suspended_Particulate_Matter_and_Turbidity.pdf (Accessed April 2019)

8 Delft (2000). Attachment E.1 (vii) Extracts from Environmental Impact of Dredging and Spoil Dumping, Delft H3544 Report, September 2000. In: Port of Waterford Company Foreshore Licence application for Maintenance Dredging FS005701. [online] Available at: https://www.housing.gov.ie/sites/default/files/migrated-files/en/Foreshore/ApplicationsandDeterminations/PortofWaterfordCompany/ApplicationDetails/FileDownLoad%2C34685%2Cen.pdf (Accessed April 2019)

9 Dixon.Brosnan (2019). Ecological Assessment of estuarine habitats at Campile estuary and terrestrial ecology in proximity to Baginbun Beach for a proposed electricity interconnector between Ireland and Wales. Revision 1. 12 April 2019.

10 EMODNet (2019). EMODnet broad-scale seabed habitat map for Europe (EUSeaMap) [online] Available at: https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/ (Accessed April 2019)

11 European Environment Agency (EEA) (2013) Reefs. [online] Available at: https://eunis.eea.europa.eu/habitats/10009 (Accessed April 2019)

12 European Commission (2013). Interpretation Manual of the European Union Habitats. Available at:

http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf (Accessed April 2019)

13 Irving, R. (2009). The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008. Peterborough: JNCC Report No.432, 2009. ISSN 0963-8091.

14 JNCC (2004) The Irish Sea Pilot Final Report. Joint Nature Conservation Committee

15 JNCC (2014). Annex I Reefs. [online] Available at: http://jncc.defra.gov.uk/PAGE-1448 (Accessed April 2019)

16 JNCC (2019). Large Shallow Inlets and Bays. [online] Available at: http://jncc.defra.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H1160 (Accessed April 2019)

17 Langhamer, O (2012). Artificial reef effect in relation to offshore renewable energy conversion. State of the art. Scientific word journal.

18 Leya, T., A. Rother, T. Müller, G. Fuhr, M. Gropius, and B. Watermann. (1999). Electromagnetic Antifouling Shield (EMAS) – A Promising Novel Antifouling Technique for Optical Systems, 10th International Congress on Marine Corrosion and Fouling. University of Melbourne, Australia. February 1999.

19 Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M. and Scheidat. (2011) Short term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6.

20 MarineSpace (2018). Greenlink Interconnector Cable Landfall Locations (Wales and Ireland) - Intertidal Walkover Survey Report 2018.

21 MarLIN (2016). Moerella spp. with venerid bivalves in infralittoral gravelly sand. [online] Available at: http://www.marlin.ac.uk/habitats/detail/1111/moerella_spp_with_venerid_bivalves_in_infralittoral_gravelly_sand (Accessed February 2019)

22 MarLIN (2019). Species and habitat Sensitivity Assessment. [online] Available at: https://www.marlin.ac.uk (Accessed April 2019)

23 MCCIP (2015). Marine climate change impacts: Implications for the implementation of marine biodiversity legislation [Online]. Available at: www.mccip.org.uk/media/1611/mccip_special_topic_report_card_-2015.pdf (Accessed June 2019).

24 MMT (2019). Environmental Field Report. Greenlink Ireland Wales Interconnector Offshore Surveys.

25 Natural Resources Canada (2019). [Online] Available at: https://www.nrcan.gc.ca/home (Accessed March 2019)

26 Nemo Link (2013). Environmental statement Vol. I, Environmental Statement and Figures.

27 Nielson, M.R. (1986). Test report. Sea electrodes for Konti-Skan 2. ELSAM Report S86/63a: 34pp.

28 NIRAS (2016). Electromagnetic Fields (EMF) – Marine Ecological Report. Viking Link.

29 Nord Stream (2014) Results of Environmental and Socio-Economic Monitoring 2014. August 2015 [Online]

Available at: https://www.nord-stream.com/press-info/library/?pk=250 (Accessed April 2019)

30 NPWS (2011a). River Barrow and River Nore SAC (site code: 2162) Conservation objectives supporting document – coastal habitats. Version 1. March 2011 [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/002162_Barrow%20Nore%20SAC%20Coastal%20Supporting%20Doc_V1.pdf (Accessed April 2019)

31 NPWS (2011b) Hook Head (site code: 0764) Conservation objectives supporting document – marine habitats. Version 1 July 2011. [online] Available at: https://www.npws.ie/sites/default/files/publications/pdf/000764_Hook%20Head%20SAC%20Marine%20Supporting_Doc_V1.pdf (Accessed April 2019)

32 NPWS (2014a) Site Synopsis, Hook Head SAC 000764. [online] Available at: https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY000764.pdf (Accessed February 2019)

33 Parry, M.E.V. (2015) Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland.

34 Pidduck, E., Jones, R., Daglish, P., Farley, A., Morley, N., Page, A. and Soubies, H. (2017). Identifying the possible impacts of rock dump from oil and gas decommissioning on Annex I mobile sandbanks – JNCC Report No: 603. [online] Available at: http://jncc.defra.gov.uk/pdf/Report_603_web.pdf (Accessed April 2019]

35 Rivier, A., Gohin, F., Bryère, P., Petus, C., Guillou, N. and Chapalain, G. (2012) Observed vs. predicted variability in non-algal suspended particulate matter concentration in the English Channel in relation to tides and waves Geo Marine Letters 32 pp 139-151

36 Stamp, T.E. and Hiscock, K. (2015). [*Laminaria hyperborea*] forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [online]. Plymouth: Marine Biological Association of the United Kingdom. Available at: https://www.marlin.ac.uk/habitat/detail/44 (Accessed April 2019)

37 Swedpower (2003). Electrotechnical studies and effects on the marine ecosystem for BritNed Interconnector.

38 Tillin, H.M. (2016). [Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [online]. Plymouth: Marine Biological Association of the United Kingdom. Available at : https://www.marlin.ac.uk/habitat/detail/1133 (Accessed April 2019)

39 Tillin, H.M. and Budd, G. (2016). Barren littoral coarse sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [online] Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/habitat/detail/16 (Accessed April 2019)

40 Ventura, A. (2018). Bivalves in the face of ocean acidification [Online]. Available at https://gupea.ub.gu.se/bitstream/2077/55377/1/gupea_2077_55377_1.pdf (Accessed June 2019)

41 Voullgaris G and Collins M.B. (2000) Sediment resuspension on beaches: response to breaking waves, Marine Geology 167 pp 167-187

42 Waardenburg, B., Lengkeek, W., Didderen, K., Teunis, M., Driessen, F., Coolen, J.W.P., Vergouwen, S.A., Raaijmakers, T.C., Vries de M.B AND Koningsveld van M (2017). Eco-friendly design of scour protection: potential enhancement of ecological functioning in offshore wind farms. [online] Available at: http://edepot.wur.nl/411374 (Accessed April 2019)

43 Wyn G, Brazier P, Birch K., Bunker A, Cooke A, Jones M, Lough N (2006). CCW Handbook for Marine Intertidal Phase 1 Biotope Mapping Survey.

44 Zimmermann, S., Zimmermann, A.M., Winters, W.D. and Cameron, I.L. (1990). Influence of 60-Hz magnetic fields on sea urchin development, Bioelectromagnetics, 11: 37-45.

Appendix C

Underwater Noise Assessment

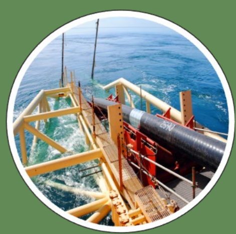
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX C

Underwater Sound Modelling

P1975_R4500_RevF1
July 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR

CONTENTS

LIST OF TABLES AND FIGURES

Tables

1. Introduction

1.1 Objective

One of the most important environmental concerns related to the installation, operation (including maintenance and repair) and decommissioning of Greenlink is the potential effects of underwater sound. Sound inputs to the marine environment will be generated by vessel movements, sand wave preparation (pre-sweeping), cable trenching, rock placement and if required, unexploded ordnance (UXO) detonations.

To determine the zone of influence for each activity (the spatial extent over which the activities are predicted to have an effect on the receiving environment) an assessment has been conducted which combines literature review with underwater sound modelling. This Technical Appendix presents the findings of the assessment. It has informed the EIA process and assessment of significant effects presented in Chapter 8 – Fish and Shellfish and Chapter 10 – Marine Mammals and Reptiles.

1.2 Underwater sound

Sounds in the ocean originate from natural causes such as earthquakes, rainfall, and animal noises; and anthropogenic activities such as shipping, fishing activities, seismic survey, research activities, sonars and recreation activities. As sound waves travel through water, they spread, dissipate and reflect off the sea surface and seabed. The local oceanographic conditions will affect the path of the sound in the water column, how much sound is transmitted, and the levels received by the receptor at distance from the source. Variables such as water depth, source and receiver depths, temperature gradients, salinity, seabed ground conditions and many other factors can affect received levels.

Although some sound sources can be identified, the sources of others cannot, and they are considered part of the background noise. How a receptor is affected by a change in underwater sound is linked to the current exposure levels and associated background noise.

1.2.1 Background sound

Measurements on anthropogenic sounds were recorded to quantify background noise levels in the UK, as part of the European Union (EU) Marine Strategy Framework Directive (MSFD) (Merchant et al. 2016). These were taken across locations in the Celtic Sea, southern North Sea (SNS) and northern North Sea (NNS). Recordings were taken at four frequency ranges (63Hz, 125Hz, 250Hz and 500Hz). Noise levels in the Celtic Sea ranged from 99.9dB (500Hz) to 102.9dB re1μPa (250Hz) (RMS[1]) (Merchant et al. 2016). These levels are lower on average than the NNS and SNS, noting that only one location was recorded in the Celtic Sea in comparison to ten in the NNS. Little is known on ambient sound levels in the vicinity of Greenlink

[1] The EU MSFD recommends the use of root mean square (RMS) noise levels as environmental indictor.

development. Background sound levels in the vicinity of the project will influence how marine species react to the introduction of new sound as part of the installation and then maintenance of the marine cable.

1.2.2 Sound categories

Underwater sound is classified between two distinct types: impulsive and continuous (i.e. non-pulse).

Impulsive sound is defined as a discrete or a series of events, for example an explosion or a seismic airgun (Southall et al. 2007). Produced impulsive sounds are generally transient and brief; peak sound pressure has a rapid rise and a rapid decline (NMFS 2018). Single pulse sound results from a single event, such as UXO detonation and pile strike (Southall et al. 2007). A repetition of pulses is considered as a multiple pulse sound source and is a series of discrete acoustic events within a 24hr period, for example a seismic survey (Southall et al. 207).

Continuous events, such as shipping noise, produce non-pulse sound and are generally broadband, narrowband or tonal. Continuous sound can either be intermittent or continuous within a 24hr period (NMFS 2018). Cable installation activities include trenching, rock placement, pre-sweeping and the use of thrusters for dynamically positioning (DP) on vessels; all of which produce continuous sound over a period of 24hrs.

2. Receptor Sensitivity to Underwater Sound Changes

2.1 Introduction

Research has largely focused on effects of underwater sound on marine mammals, but in the last few years evidence of effects in other species such as fish (Popper *et al*. 2014), crustaceans (Solan *et al*. 2016, Tidau and Briffa 2016) and zooplankton (McCauley *et al*. 2017) have been reported.

2.2 Marine mammals

Both cetaceans and pinnipeds have evolved to use sound as an important aid in navigation, communication and hunting (Richardson *et al*. 1995). It is generally accepted that exposure to anthropogenic sound can induce a range of behaviour effects to permanent injury in marine mammals. Loud and prolonged sound above background levels is considered to be noise and may have an effect on marine life. This may mask communicative or hunting vocalisations, preventing social interactions and effective hunting.

High intensity noises such as from seismic survey, explosions and pile driving can cause temporary or permanent changes to animals' hearing if the animal is exposed to the sound in close proximity and, in some circumstances, can lead to the death of the animal (Richardson *et al*. 1995). Where the threshold of hearing is temporarily damaged, it is considered a temporary threshold shift (TTS), and the animal is expected to recover. If there is permanent damage (permanent threshold shift (PTS)) where the animal does not recover, social isolation and a restricted ability to locate food may occur, potentially leading to the death of the animal (Southall *et al*. 2007).

Behavioural disturbance from underwater sound sources is more difficult to assess than injury and is dependent upon many factors related to the circumstances of the exposure (Southall *et al*. 2007, NMFS 2018). An animal's ability to detect sounds produced by anthropogenic activities depends on its hearing sensitivity and the magnitude of the noise compared to the amount of natural ambient and background anthropogenic sound. In simple terms for a sound to be detected it must be louder than background and above the animal's hearing sensitivity at the relevant sound frequency.

Behavioural responses caused by disturbance may include animals changing or masking their communication signals, which may affect foraging and reproductive opportunities or restrict foraging, migratory or breeding behaviours; and factors that significantly affect the local distribution or abundance of the species. An animal may swim away from the zone of disturbance and remain at a distance until the activities have passed. Behavioural disturbance to a marine mammal is hereafter considered as the disruption of behavioural patterns, for example: migration, breeding and nursing.

2.3 *Sea turtles*

Sea turtles are known to be able to detect (Ridgway et al. 1969, Bartol et al. 1999, Bartol & Ketten 2006) and respond to acoustic stimuli (Lavender et al. 2014, Martin et al. 2012, O'Hara & Wilcox 1990, DeRuitter & Doukara 2012), which they may use for navigation, prey location, predator avoidance as well as general environmental awareness (Piniak et al. 2016). Sea turtles have adapted their hearing for use underwater. It is likely that their body serves as a receptor while the turtle is underwater (Lenhardt 1983, 1985).

Electrophysiological and behavioural studies have demonstrated that sea turtles are able to detect low-frequency sounds both underwater and in air (Piniak et al. 2016). Sea turtles respond to aerial sounds between 50 and 2000 Hz and vibrational stimuli between 30 and 700 Hz, with maximum sensitivity values recorded between 300 and 500 Hz for both sounds (Ridgway et al. 1969).

Green turtles respond to underwater signals between 50 Hz to 1600 Hz, with maximum sensitivity between 200 and 400 Hz (Piniak et al. 2016). These values are similar to findings by Bartol & Ketten (2006).

Similarly, adult Loggerhead sea turtle responded to underwater stimuli between 50 and 800 Hz with best sensitivity at 100 Hz using behavioural response techniques, while between 100 and 1131 Hz with best sensitivity between 200 and 400 Hz when using AEP techniques (Martin et al. 2012).

Overall, the biological significance of hearing in sea turtles remains poorly understood, but as low-frequency sound is most prevalent and travels the farthest in the marine environment there may be some advantage to sea turtles in specializing in low-frequency sound detection. It is therefore believed that acoustic sound may provide important environmental cues for sea turtles (Piniak et al. 2016).

Popper et al. (2014) provide sound exposure guidelines for injury to sea turtles.

2.4 Fish

In general, most fish hear well in the range within which most energy from anthropogenic noise sources is emitted, i.e. relatively low frequency sound below 1 kHz, with peak perception between approximately 100-400 Hz.

Several features of a fish's anatomy, life cycle and habitats will determine the potential effects of sound on fish. Popper et al. (2014) classified sensitivity of fish species to underwater sound based on the presence or absence of swim bladder; the otolith organ acts as a particle motion detector and where linked to the swim bladder, converts sound pressure into particle motion, which is detected by the inner ear. Specialist hearing species include species such as herring, sprat, twaite shad and allis shad.

Swim bladder are used by certain fish species for buoyancy control, hearing, respiration etc. Pressure changes for fish with a swim bladder, in particular from impulsive sound, can result in physiological trauma.

Popper et al. (2014) provide sound exposure guidelines for injury to fish, which have been used in the modelling presented in Table 3-3.

2.5 Crustaceans

Little is known about how crustacean species are impacted by underwater sound changes (Tidau and Briffa 2016). Recent studies identified that crustaceans, both freshwater and marine species, are likely to be impacted by underwater sound changes. Unlike fish species, crustaceans do not have an air-filled chamber; therefore, they are unlikely to detect sound pressure but can be sensitive to particle motion (Tidau and Briffa 2016).

Studies have considered the impact and the behavioural responses of crustaceans to airgun sounds. Results from these studies produced varied results. A field study on shrimp species and American lobster did not identify an avoidance behaviour while a behavioural response was identified during laboratory test (Andriguetto-Filho et al. 2005; Parry and Gason, 2006 in Tiday and Briffa 2016). A stress response to noise (airguns) was noticed (increase in food intake). Impacts of impulsive pile driving on Norway lobster showed a change in behaviour, as such reduced burrowing and mobility (Solan et al. 2016).

These studies identified a large array of responses to underwater sound pressure, from an increase in behaviour (for example an increase in food intake in lobsters), stress responses, slower or reduced behaviour, change in foraging habitats etc. The current knowledge on how these reactions are displayed however is based on a limited range of studies (Tidau and Briffa 2016).

2.6 Zooplankton

Zooplankton are highly mobile at small scales or across small scales (McManus & Woodson 2012, Bianco et al. 2014, Visser 2007); however, research suggest that they cannot move away from an approaching air gun array (i.e. an impulsive sound) produced during seismic surveys. Recent scientific evidence also suggests that low-frequency impulse sound leads to significant mortality to zooplankton populations (McCauley et al. 2017).

A decrease in zooplankton abundance was recorded during experimental air gun signal exposure when compared to the absence of air gun signal, as measured by sonar (~3–4 dB drop within 15–30 min) and net tows (median 64% decrease within 1 hour). In addition, this caused an increase in mortality for adult and larval zooplankton (McCauley et al. 2017). The impacts of air guns on zooplankton have been observed out to the maximum 1.2 km range sampled (McCauley et al. 2017).

Further studies on larval invertebrates also showed significant malformations to scallop veliger larvae from simulated air gun exposure (de Soto et al. 2013), while no impacts were detected on larval hatching success or viability immediately after hatchment for lobster eggs exposed to an air gun in the field (Day et al. 2016).

The knowledge of effects from underwater sound on zooplankton communities is very sparse with little scientific evidence, besides from recent research by McCauley et al. (2017) described above.

3. Results and Discussion

3.1 Marine mammals

3.1.1 Injury and disturbance thresholds

Effects of underwater sound changes range from injury through to disturbance. To calculate the zone of influence for both levels of effect, sound propagation calculations have been used to determine the range at which the received sound attenuates to levels below a defined threshold. The thresholds used in the calculations are explained below.

3.1.1.1 Injury thresholds

The assessment has used both the recently published American National Marine Fisheries Service (NMFS) (2018) thresholds for the onset of PTS and TTS and the thresholds defined by Southall *et al.* (2007). Both approaches separate marine mammals into five groups based on their functional hearing, namely: low-frequency cetaceans; mid frequency cetaceans; high frequency cetaceans; pinnipeds (Phocid) in water; and pinnipeds (Otariid) in water. Table 3-1 presents the species identified as present along the Greenlink route according to their functional hearing category.

Table 3-1 Marine mammal auditory bandwidth

Group	Low-frequency cetaceans	Mid-frequency cetaceans	High-frequency cetaceans	Pinnipeds (Phocid) in water	Otariid and other non-phocid marine carnivores in water
Generalised hearing range (NMFS 2018)	7Hz - 35kHz	150hz - 160kHz	275Hz - 160kHz	50Hz - 86kHz	60Hz - 39kHz
Species	Baleen whales	Most toothed whales, dolphins	Certain toothed whales, porpoises	True seals	Otter
Species observed along Greenlink route	Minke whale Humpback whale Fin whale	Short-beaked common dolphin Common bottlenose dolphin Stripped dolphin Risso's dolphin Atlantic white-sided dolphin White-beaked dolphin Long-finned pilot whale Killer whale	Harbour porpoise	Grey seal Harbour seal	Common otter

Source: NMFS (2018)

The thresholds for the onset of PTS and TTS, as published in NMFS (2018) and Southall *et al*. (2007), are provided in Table 3-2. These reflect the current peer-reviewed published state of scientific knowledge.

Table 3-2 Injury thresholds for marine mammals from impulsive (SPL, unweighted) and continuous (SEL, weighted) sound

Group	SPL (unweighted) - impulsive sound				SEL (weighted) - continuous sound			
	NMFS (2018)		Southall *et al*. (2007) *		NMFS (2018)		Southall *et al*. (2007)	
	PTS (dB re 1 µPa (peak))	TTS (dB re 1 µPa (peak))	PTS (dB re: 1 µPa (peak))	TTS (dB re: 1 µPa (peak))	PTS (dB re 1 µPa^2 s)	TTS (dB re 1 µPa^2 s)	PTS (dB re: 1 µPa^2-s)	TTS (dB re: 1 µPa^2-s)
Low-frequency cetaceans	219	213	230	224	199	179	198	183
Mid-frequency cetaceans	230	224	230	224	198	178	198	183
High-frequency cetaceans	202	196	230	224	173	153	198	183
Pinnipeds (Phocid) in water	218	212	218	212	201	181	186	171
Pinnipeds (Otariid) in water	232	226	-	-	219	199	-	-

Source: Southall *et al*. (2007); NMFS (2018)

Note: * Single pulse

3.1.1.2 Disturbance thresholds

NMFS has not yet published guidelines on behaviour thresholds due to the complexity and variability of the responses of marine mammals to anthropogenic disturbance.

For the purposes of this assessment the threshold for behavioural disturbance has been assessed as 160 dB rms (SPL - impulsive sound) and 120 dB rms (SEL - continuous sound) for all cetacean species (Gomez et al. 2016, BOEM 2017, NMFS 2018).

3.1.1.3 Modelling

Sound attenuates as it propagates through water and the local oceanographic conditions will affect both the path of the sound into the water column and how much sound is transmitted. An in-house geometric spreading calculation was used to determine the propagation of underwater sound from the activities. The spreading model assumes that sound is spread geometrically away from the source with an additional frequency-dependent absorption loss; it therefore provides conservative estimates. It also does not take into consideration the conditions within the area, such as bathymetry, water depth or sediment type and thickness.

Attenuation used in the geometric spreading calculation can be calculated using the equation below:

SPL = SL – 15log (R). In this equation:

SPL = sound pressure level

SL = source level

R = the distance from a source level (SL)

15 = attenuation value associated with spreading in shallow water, allowing for losses to the seabed.

This equation does not include any terms relating to frequency (MMO 2015).

The NMFS recently developed a spreadsheet tool to estimate at which range (or distances) PTS (permanent injury) could effect marine mammals (NMFS 2018). This spreading model considers weighting factor adjustments and frequency, as well as source level, as part of its calculation. It was used to confirm the PTS results obtained from the geometric spreading modelling. The NMFS (2018) spreadsheet does not provide values for TTS.

A literature review was performed to obtain the source levels to inform this assessment and modelling (results provided in Table 3-3). No project-specific data was available, and the literature review identified appropriate sound sources to use.

Nedwell et al. (2003) provided an unweighted source level for trenching operations during trenching at North Hoyle; this is assumed to be 178dB re µPa @ 1m. The trenching noise was considered to be a mixture of broadband noise, tonal machinery noise and transients. During trenching at North Hoyle, sound was recorded as highly variable, and assumed to be dependent on the physical properties of the particular area of seabed that was being cut at the time (Nedwell et al. 2003). There is no publicly available data providing sound exposure levels (SEL) associated with trenching operations. The source level provided in Nedwell et al. (2003) is unweighted; therefore, this has been compared against SPL (unweighted) thresholds from the NMFS (2018) and Southall et al. (2007).

Genesis Oil and Gas Consultants (2011) listed the sound levels of DP vessels; a worst-case 184dB B re 1 μPa @ 1m was used for the assessment below.

Studies showed that rock placement did not generate a noticeable rise in the level of underwater sound, compared to the presence of vessels (including those using dynamic positioning). This indicates the sound levels are dominated by the vessel noise and not the rock dumping activities (Nedwell and Edwards 2004). Wyatt (2008) recommended the use of 188dB (rms) 1μPa @1m, which was converted to 191dB (0-peak) 1μPa @1m.

Received sound by marine mammals from the geophysical survey are considered as near-continuous, rather than impulsive. However, there are no publicly available data on sound exposure levels (SEL) for the geophysical equipment. For the purpose of this assessment, sound pressure levels (SPL), which are more readily available, have been used instead to compare the sound levels of the geophysical equipment and borehole drilling against PTS and TTS thresholds (for near-continuous noise the thresholds are provided in SEL as this accounts for the time element as well as the noise level whereas impulsive just considers the noise).

Modelling results, i.e. the distances from the source at which sound levels will diminish to below the injury and disturbance thresholds, are summarised in Table 3-3.

Table 3-3 Summary of results – cable installation and geophysical survey

Auditory group	Threshold			Distance in metres at which threshold is exceeded						
				DP vessel *	Trenching **	Rock placement ***	Geophysical survey			
							Multibeam echosounder (MBES)*	Sidescan sonar (SSS)*	Sub-bottom profiling: chirper / pinger*	Sub-bottom profiling: boomer *
				SPL: 184dB dB re 1 µPa @ 1m Frequency: 63Hz	SPL: 178dB re 1 µPa @ 1 m Frequency: 125Hz	SPL(0-peak): 191dB re: 1µPa @1m Frequency: 10kHz	SPL: 232dB(rms)re 1µPa @1m (converted to 235 dB0-peak re 1µPa2-s) * Frequency: 95kHz	SPL: 226dB(rms) re 1µPa @1m (converted to 229 dB0-peak re 1µPa2-s) * Frequency: 114kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 1.5kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 2.5kHz
Low-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	219	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	15	5	Threshold not exceeded	Threshold not exceeded
		Southall *et al.*	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS	213	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	40	13	Threshold not exceeded	Threshold not exceeded
		Southall	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
Mid-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
		Southall								
	TTS (dB re 1 µPa (peak))	NMFS	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
		Southall								
High-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	202	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	110	60	4.6	4.6
		Southall	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded

Auditory group	Threshold			Distance in metres at which threshold is exceeded						
				DP vessel *	Trenching **	Rock placement ***	Geophysical survey			
							Multibeam echosounder (MBES)*	Sidescan sonar (SSS)*	Sub-bottom profiling: chirper / pinger*	Sub-bottom profiling: boomer *
				SPL: 184dB dB re 1 µPa @ 1m Frequency: 63Hz	SPL: 178dB re 1 µPa @ 1 m Frequency: 125Hz	SPL(0-peak): 191dB re: 1µPa @1m Frequency: 10kHz	SPL: 232dB(rms)re 1µPa @1m (converted to 235 dB0-peak re 1µPa2-s) * Frequency: 95kHz	SPL: 226dB(rms) re 1µPa @1m (converted to 229 dB0-peak re 1µPa2-s) * Frequency: 114kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 1.5kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 2.5kHz
	TTS (dB re 1 µPa (peak))	NMFS	196	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	180	110	11	11
		Southall	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
Pinnipeds (Phocid) in water	PTS (dB re 1 µPa (peak))	NMFS	218	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	15	7	Threshold not exceeded	Threshold not exceeded
		Southall								
	TTS (dB re 1 µPa (peak))	NMFS	212	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	40	15	Threshold not exceeded	Threshold not exceeded
		Southall								
Otter in water	PTS (dB re 1 µPa (peak))	NMFS	232	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS	226	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	4.6	2	Threshold not exceeded	Threshold not exceeded
All cetaceans	Disturbance (dB rms)	BOEM, NMFS	160	50	17	130	940	720	2,600	2,500

Source: Southall *et al.* (2007), Popper *et al.* (2014), BOEM (2017), NMFS (2018)

Source: * Genesis Oil & Gas Consultants (2011), ** Nedwell *et al.* (2003), *** Wyatt (2008), † Based on 734kg explosive (sea mine).

Note: Sound generated by vessel movement, pre-sweeping, trenching and rock placement is continuous. However, there is no publicly available data on SEL for these activities. Therefore, SPL input values and thresholds have been used to assess sound generated by these activities.

3.1.1.4 Zone of influence

The geometric spreading model results indicate that for activities which generate continuous (cable installation) or near-continuous (geophysical survey) sound:

- Cable installation activities (DP vessels, rock placement and trenching):
  - No cetaceans, pinnipeds or otters are at risk of permanent or temporary injury.
  - The zone of influence for disturbance is 130m (all cetaceans).
- Geophysical survey (multi-bean echosounder, side-scan sonar, sub-bottom profiler)
  - The zone of influence for permanent injury is 110m (high-frequency cetaceans).
  - The zone of influence for temporary injury is 180m (high-frequency cetaceans).
  - The zone of influence for disturbance is 2.6km (all cetaceans).
  - Otters are at risk of permanent injury within 2m of the source.
  - Otters are at risk of temporary injury within 4.6m of the source.

3.1.2 Activities generating impulsive sound

This section models and discusses the detonation of UXO. This activity, if required, would be undertaken during the installation phase, and potentially during operation (principally maintenance and repair).

3.1.2.1 Modelling

Should UXO be found, which require clearance by detonation, there would be a relatively large release of impulsive sound energy. Peak source levels would depend on the quantity and nature of explosive material.

A desk-based UXO risk assessment conducted for Greenlink by 1st Line Defence (2018), identified that of the UXO that could be present along the cable route, size would range from 14kg up to 794kg. British sea mines were considered as a worst-case, containing up to 794kg of explosives. It is important to note that the desk-based study has not identified the number or locations of UXOs but provides a review of the type most likely to occur.

The source level of explosives can be predicted if certain parameters are known, such as the weight of the charge (w) and depth of detonation. The SPL (0-peak) of the initial shock wave, the largest amplitude component, is given by the formulae:

SPL (0-peak) dB re1μPa @ 1m = 271 dB + 7.533(log)(w)

Using this equation and based on 794kg as the weight of charge, the worst-case SPL(0-peak) is 293dB re1μPa @ 1m.

The results from the equation have been compared to measured SPLs from UXO detonations. Genesis Oil and Gas Consultants (2011) summarise information collected by Nedwell *et al*. (2001) during explosive operations in support of wellhead decommissioning. Measurements of sound pressure levels were taken at two locations: the CSO Seawell in a standoff position 600-800m from the wellhead; and seabed mounted hydrophones at different ranges. Sound pressure levels were recorded for charge sizes between 36kg and 81kg at varying water depths (see Table 3-4).

If the formula is used to calculate the SPL (0-peak) for a 36kg charge it concludes a value of 283 dB re1μPa @ 1m. Assuming spherical spreading from the explosion, then the SPL will attenuate to 227 dB re1μPa @ 600m. This figure is 6dB higher than the measured SPL @ 650m recorded by Nedwell *et al*. (2001) presented in row 1 of Table 3-4 above, suggesting that the calculations using the formula are conservative.

Table 3-4 SPLs (0-peak) recorded from the detonation of explosive charges measured from the CSO Seawell adapted from Nedwell *et al*. (2001)

Range (m)	Charge size (kg)	Depth of hydrophone	Received level (0-Peak) dB re1μPa @ range
650	36	30	221 dB re1μPa @ 650m
650	36	25	222 dB re1μPa @ 650m
800	36	30	221 dB re1μPa @ 800m
575	45	30	211 dB re1μPa @ 575m
575	45	25	211 dB re1μPa @ 575m
600	45	40	213 dB re1μPa @ 600m
600	45	35	214 dB re1μPa @ 600m
600	45	30	214 dB re1μPa @ 600m
600	45	25	214 dB re1μPa @ 600m
650	45	40	216 dB re1μPa @ 650m
650	45	35	218 dB re1μPa @ 650m
650	45	40	218 dB re1μPa @ 650m
650	45	35	217 dB re1μPa @ 650m
650	45	40	221 dB re1μPa @ 650m
650	45	35	217 dB re1μPa @ 650m
650	45	40	221 dB re1μPa @ 650m
650	45	35	221 dB re1μPa @ 650m
650	45	30	218 dB re1μPa @ 650m
650	45	25	217 dB re1μPa @ 650m
75	45	116	227 dB re1μPa @ 75m
125	45	87	226 dB re1μPa @ 125m
200	45	110	225 dB re1μPa @ 200m
300	45	91	232 dB re1μPa @ 300m
300	45	84	230 dB re1μPa @ 300m

Range (m)	Charge size (kg)	Depth of hydrophone	Received level (0-Peak) dB re1µPa @ range
400	45	108	223 dB re1µPa @ 400m
600	73	30	220 dB re1µPa @ 600m
650	73	25	226 dB re1µPa @ 650m
600	81	30	220 dB re1µPa @ 600m
600	81	25	226 dB re1µPa @ 600m

Source: Genesis Oil and Gas Consultants (2011)

Table 3-5 presents the results of the modelling assuming a SPL(0-peak) of 293dB re: 1µPa @1m for a 794kg charge.

Table 3-5 Summary of results - UXO detonation (worst-case 794kg explosive detonation)

Auditory group	Threshold			Distance in km at which threshold is exceeded
				SPL(0-peak): 293dB re: 1µPa @1m * Frequency: 10kHz
Low-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	219	13
		Southall *et al.*	230	5.8
	TTS (dB re 1 µPa (peak))	NMFS	213	16
		Southall	224	8.6
Mid-frequency cetaceans	PTS (dB re 1 µPa	NMFS	230	5.8
		Southall		
	TTS (dB re 1 µPa (peak	NMFS	224	8.6
		Southall		
High-frequency cetaceans	PTS (dB re 1 µPa (peak	NMFS	202	23
		Southall	230	5.8
	TTS (dB re 1 µPa (peak	NMFS	196	27
		Southall	224	8.6
Pinnipeds (Phocid) in water	PTS (dB re 1 µPa (pea)	NMFS	218	13
		Southall *et al.*		
	TTS (dB re 1 µPa (peak	NMFS	212	17
		Southall *et al.*		
Otters in water	PTS (dB re 1 µPa (pea)	NMFS	232	5
	TTS (dB re 1 µPa (p))	NMFS	226	7.6
All cetaceans	Disturbance (db rms)	BOEM, NMFS	160	54

Source: Southall *et al.* (2007), Popper *et al.* (2014), BOEM (2017), NMFS (2018)

Source: * Calculated using Ulrick (1975) equation, using 794kg weight

3.1.2.2 Zone of influence

The modelling indicates that for UXO detonation which generates impulsive sound:

- High-frequency cetaceans are at risk of permanent injury within 23km of the source.
- High-frequency cetaceans are at risk of temporary injury within 27km of the sound source.
- Seal are at risk of permanent injury within 13km of the source.
- Seal are at risk of temporary injury within 17km.
- The zone of influence for permanent injury for otters is 5km.
- The zone of influence for temporary injury for otters is 7.6km.
- All cetaceans are at risk of disturbance within 54km of source.

3.2 Sea turtles

3.2.1 Continuous sound

A review of sound exposure on sea turtles by Popper *et al*. (2014) identified no existing data regarding the effect of continuous sound.

3.2.2 Impulsive sound – UXO detonation

There is little information on the effects of impulsive sound on marine turtles. Some studies identified that the use of explosives in the Gulf of Mexico for oil and activities resulted in the mortality or injury of some individuals, probably due to the quick change in pressure associated with detonations (Popper *et al*. 2014).

Modelling, using the same approach as for cetaceans, presented in Table 3-6 indicates that sea turtles are risk of mortality and potential mortal injuries within 6.2km.

Table 3-6 Summary of results for UXO - sea turtles

Auditory group	Threshold			Distance in km at which threshold is exceeded SPL(0-peak): 293dB re: 1µPa @1m * Frequency: 10kHz
Sea turtles	Mortality and potential mortal injury	Popper *et al.*	229 -234dB re 1 µPa (peak)	4.2 - 6.2

3.3 Fish

3.3.1 Continuous sound source

Popper *et al*. (2014) identified that there is no direct evidence of permanent injury to fish species from shipping and other continuous noise (such as the cable installation and near-continuous sound produced by geophysical equipment). The Oslo and Paris (OSPAR) Commission (2012) considered that the potential for likely significant effects to fish from cable installation activities is considered to be minor.

Different fish species react differently to sound. Behavioural responses may include small movement or escape responses, based on studies conducted in laboratories (The University of Rhode Island 2017).

Continuous sound is detectable by fish species, and it is possible that this could lead to masking. However, masking and behavioural changes in fish from continuous sound is currently unknown (Popper *et al*. 2014). It is unlikely that fish species will be significantly affected by sound changes during the cable installation activities.

3.3.1.1 Modelling

Modelling results, i.e. the distances from the source at which sound levels will diminish to below the injury and disturbance thresholds, are summarised in Table 3-7.

Table 3-7 Summary of continuous sound results - fish

		Threshold	Recoverable injury	TTS
			173dB re 1 μPa†	161dB re 1 μPa†
Activity	Source	Frequency	Distance in metres at which threshold is exceeded	
DP vessel *	SPL: 184dB dB re 1 μPa @ 1m	Frequency: 63Hz	7	50
Trenching **	SPL: 178dB re 1 μPa @ 1 m	Frequency: 125Hz	2.6	16
Rock placement ***	SPL(0-peak): 191dB re: 1μPa @1m	Frequency: 10kHz	17	110
MBES*	SPL: 232dB(rms)re 1μPa @1m (converted to 235 dB0-peak re 1μPa2-s) *	Frequency: 95kHz	630	910
SSS*	SPL: 226dB(rms) re 1μPa @1m (converted to 229 dB0-peak re 1μPa2-s) *	Frequency: 114kHz	450	700
Chirper / pinger*	SPL: 208dB(rms) re 1μPa @1m (converted to 211 dB0-peak re 1μPa2-s) *	Frequency: 1.5kHz	350	2,200

		Threshold	Recoverable injury	TTS
			173dB re 1 µPa†	161dB re 1 µPa†
Activity	Source	Frequency	Distance in metres at which threshold is exceeded	
Boomer *	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) *	Frequency: 2.5kHz	350	2,200

Note: † Popper *et al*. (2014) provide thresholds in dB (rms) for recoverable injury and TTS. These have been derived in 0-peak. Recoverable injury threshold is 170dB rms for exposure of 48hrs and TTS threshold is 158dB rms for exposure of 14hrs.

3.3.1.2 Zone of influence

The geometric spreading model results indicate for activities which generate continuous (cable installation) or near-continuous (geophysical survey) sound:

- Cable installation (DP vessels, rock placement and trenching):
  - The zone of influence for fish recoverable injury is 17m.
  - The zone of influence for temporary injury for fish is 110m.
- Geophysical survey (multi-bean echosounder, side-scan sonar, sub-bottom profiler)
  - The zone of influence for fish recoverable injury is 630m.
  - The zone of influence for temporary injury for fish is 2,200m.

3.3.2 Impulsive sound - UXO

Underwater explosion produces a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs. Damage to visceral organs is most often the cause of fish mortality following exposure to underwater explosions. The most commonly injured organs are those with air spaces that are affected by the explosion's shock wave passing through the body of the fish, these include the body cavity, the pericardial sack and gut, however injuries of the swim bladder are most common. The swim bladders are subject to rapid contraction and overextension in response to explosive shock waveforms. Species which do not possess a swim bladder or have small swim bladders are likely to be more resistant to noise generated from explosions (Keevin and Hempen 1997).

Popper *et al* (2014) also highlighted that there is no data on the effects of an explosion (such as UXO for example) on hearing or behaviour available. It is possible that a detonation can lead to temporary or partial loss of hearing at high sound levels, especially for fish species having a swim bladder which enhances sound detection. The time interval between explosions can also a key factor in fish species resilience to detonation (Popper *et al*. 2014).

If an UXO detonation is required, it is likely that any individual adult and juvenile fish present in vicinity of the explosion zone of influence will be injured or killed.

3.3.2.1 Modelling and zone of influence

Modelling, using the same approach as for cetaceans, presented in Table 3-8 indicates that fish are risk of mortality and potential mortal injuries within 6.2km.

Table 3-8 Summary of results for UXO - fish

Auditory group	Threshold			Distance in km at which threshold is exceeded
				SPL(0-peak): 293dB re: 1µPa @1m * Frequency: 10kHz
Fish	Mortality and potential mortal injury	Popper *et al.*	229 -234 dB re 1 µPa (peak)	4.2 - 6.2

3.4 *Crustaceans*

There is no threshold for the assessment of sound exposure for crustaceans (Tidau and Briffa 2016).

3.5 *Zooplankton*

There is no threshold for the assessment of sound exposure for zooplankton (Solan *et al*. 2016, McCauley *et al*. 2017).

4. Conclusion

4.1 *Zones of Influence*

The zones of influence to be used in the EIA process are summarised in the Tables below as follows:

- Table D4-1 - Continuous sound from cable installation;
- Table D4-2 – Continuous sound from geophysical survey (MBES, SBP, SSS); and
- Table D4-3 – Impulsive sound from UXO detonation (worst-case 794kg explosive).

Table 4-1 Zones of influence for continuous sound – cable installation

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	Not exceeded	Not exceeded	130m
Mid-frequency cetaceans	Not exceeded	Not exceeded	130m
High-frequency cetaceans	Not exceeded	Not exceeded	130m
Seals in water	Not exceeded	Not exceeded	130m
Otters in water	Not exceeded	Not exceeded	130m
Fish (swim bladder used for hearing, primary pressure detection)	-	50m	-
Sea turtles	-	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

Table 4-2 Zones of influence used in EIA process for continuous sound – geophysical survey

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	15m	40m	2,600m
Mid-frequency cetaceans	2.6m	7m	2,600m
High-frequency cetaceans	110m	180m	2,600m
Seals in water	15m	40m	2,600m
Otters in water	2m	4.6m	2,600m
Fish (swim bladder used for hearing, primary pressure detection)	-	2,200m	-
Sea turtles	-	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

Table 4-3 Zones of influence used in EIA process for impulsive sound – UXO detonation

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	13km	16km	54km
Mid-frequency cetaceans	5.8km	8.6km	54km
High-frequency cetaceans	23km	27km	54km
Seals in water	13km	17km	54km
Otters in water	5km	7.6km	54km
All fish species	6.2km	-	-
Sea turtles	6.2km	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

REFERENCES

1 Alcaraz, M. & Calbet, A., (2009). Zooplankton ecology. Marine Ecology, p.295.

2 Andriguetto-Filho, J. M., Ostrensky, A., Pie, M. R., Silva, U. A., and Boeger, W. A. (2005). Evaluating the impact of seismic prospecting on artisanal shrimp fisheries, Continental Shelf Research 25, 1720-1727.

3 Bartol, S.M., Musick, J.A., Lenhardt, M., (1999). Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta). Copeia 3:836–840.

4 Bartol, S.M., Ketten, D.R., (2006). Turtle and tuna hearing. In: Swimmer Y, Brill R, editors. Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. NOAA (Natl Ocean Atmos Adm) Tech Mem NMFS-PIFSC-7, pp 98–105.BEIS (2018). Offshore Oil & Gas Licensing 30th Seaward Round. Habitat Regulations Assessment. Draft Appropriate Assessment: Southern North Sea. February 2018. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/681627/30th_Round_Draft_AA_-_Southern_North_Sea_Blocks.pdf (Accessed March 2019)

5 Bianco, G., Mariani, P., Visser, A.W., Mazzocchi, M.G. and Pigolotti, S., 2014. Analysis of self-overlap reveals trade-offs in plankton swimming trajectories. Journal of The Royal Society Interface, 11(96), p.20140164.

6 BOEM (2017). BOEM: Best Management Practices Workshop for Atlantic Offshore Wind Facilities. Overview of NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing. [online] Available at: https://www.boem.gov/Day-1-Scholik-Overview-Guidance/ (Accessed March 2019)

7 Brandt T,M.J.,Dragon A.C., Diederichs A., Schubert A., Kosarev V., Nehl, G., Wahl, V., Michalik, A., Braasch, A., Hinz C., Ketzer, C., Todeskino, D., Gauger, M., Laczny, M. & Piper, W. (2016). Effects of offshore pile driving on harbour porpoise abundance in the German Bight 2009-2013. Assessment of Noise Efects. Work package 2-5, Revision 3. Final report. Prepared for Offshore Forum Windenergie. P. 247. IBL Umweltplanung GmbH, Institut für angewandte Ökosystemforschung GmbH, BioConsult SH GmbH & Co. KG, Oldenburg, Neu Broderstorf, Husum.

8 Day, R.D., McCauley, R.D., Fitzgibbon, Q.P. and Semmens, J.M., 2016. Seismic air gun exposure during early-stage embryonic development does not negatively affect spiny lobster Jasus edwardsii larvae (Decapoda: Palinuridae). Scientific reports, 6, p.22723.

9 DeRuitter, S.L., Doukara, K.L., (2012). Loggerhead turtles dive in response to airgun sound exposure. Endanger Species Res 16:55–63.

10 De Soto, N.A., Delorme, N., Atkins, J., Howard, S., Williams, J. and Johnson, M., 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. Scientific reports, 3, p.2831.

11 Genesis Oil and Gas Consultants (2011). Review and Assessment of Underwater Sound Produced from Oil and Gas Sound

Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Report for the Department of Energy and Climate Change. [online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/50017/finreport-sound.pdf (Accessed March 2019)

12 Gomez, C., Lawson, J. W., Wright, A. J., Buren, A. D., Tollit, D., and Lesage, V. (2016). A systematic review of the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Canadian Journal of Zoology. November 2016. DOI: 10.1139/cjz-2016-0098

13 Keevin, T.M., and Hempen, G.L., (1997). The Environmental Effects Of Underwater Explosions With Methods To Mitigate Impacts. [online] Available at: https://semspub.epa.gov/work/01/550560.pdf (Last Accessed April 2019)

14 Lavender, A.L., Bartol, S.M., Bartol, I.K., (2014). Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (Caretta caretta) using a dual testing approach. J Exp Biol 217:2580–2589. pmid:24855679.

15 Lenhardt, M.L., Bellmund, S., Byles, R.A., Harkins, S.W., Musick, J.A., (1983). Marine turtle reception of bone-conducted sound. J Aud Res 23:119–125. pmid:6679547

16 Lenhardt ML, Klinger RC, Musick JA (1985) Marine turtle middle-ear anatomy. J Aud Res 25:66–72. pmid:3836997

17 Marine Management Organisation (MMO) (2015). Modelled Mapping of Continuous Underwater Noise Generated by Activities. A report produced for the Marine Management Organisation, pp 50. MMO Project No: 1097. ISBN: 978-1-909452-87-9

18 Martin, K.J., Alessi, S.C., Gaspard, J.C., Tucker, A.D., Bauer, G.B., Mann, D.A., (2012). Underwater hearing in the loggerhead sea turtles (Caretta caretta): a comparison of behavioural and auditory evoked potential audiograms. J Exp Biol 215:3001–3009. pmid:22875768.

19 McCauley, R.D., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A. and Semmens, J.M., (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution, 1(7), p.0195.

20 McManus, M.A. and Woodson, C.B., (2012). Plankton distribution and ocean dispersal. Journal of Experimental Biology, 215(6), pp.1008-1016.

21 Merchant, N. D., Brookes, K. L., Faulkner, R. C., Bicknell, A. W. J., Godley, B. J. and Witt, M. J. (2016). Underwater noise levels in UK waters. Sci. Rep. 6, 36942; doi: 10.1038/srep36942. [online] Available at: https://www.nature.com/articles/srep36942.pdf (Accessed March 2019)

22 National Research Council (2003). Ocean Noise and Marine Mammals. Washington, DC: The National Academies Press. https://doi.org/10.17226/10564.

23 Nedwell, J.R., Needham, K., Gordon, J., Rogers, C. and Gordon, T. (2001). The effects of underwater blast during wellhead severance in the North Sea. Subacoustech.

24 Nedwell, J., Langworthy, J. and Howell, D. (2003). Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms,

and comparison with background noise. Report No. 544 R 0424. May 2003. [online] Available at: http://www.subacoustech.com/information/downloads/reports/544R0424.pdf (Accessed March 2019)

25 Nedwell, J.R, and Edwards, B. (2004). A review of the measurement of underwater man made noise carried out by Subacoustech Ltd. Subacoustech Ltd

26 National Marine Fisheries Service (NMFS) (2018). 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

27 O'Hara, J., Wilcox, J.R., (1990). Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sound. Copeia. 2:564–567.

28 OSPAR Convention (2012). Guidelines on Best Environmental Practice (BEP) in Cable Laying and Operation. Agreement 2012-2. Source: OSPAR 12/22/1, Annex 14. [online] Available at: https://www.gc.noaa.gov/documents/2017/12-02e_agreement_cables_guidelines.pdf (Accessed March 2019)

29 Parry, G. D., and Gason, A. (2006). The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia, Fisheries Research 79, 272-284.

30 Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., Ellison, W. T., Gentry, R. L., Halvorsen, M. B., Løkkebog, S., Rogers, P. H., Southall, B. L., Zeddies, D. G., and Tavolga, W. N. (2014). Sound Exposure Guidelines for Fishes and Sea Turles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

31 Piniak, W.E.D., Mann, D,A,, Harms, C.A., Jones, T.T., Eckert, S.A., (2016). Hearing in the Juvenile Green Sea Turtle (Chelonia mydas): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. PLoS ONE 11(10): e0159711.

32 Raymont, J. E. G., (1983). Plankton and Productivity in the Oceans. Vol. 2 - Zooplankton. 2nd edition, viii, 824 pp. Pergamon Press.

33 Richardson, W.J., Greene, C.R. Jr., Malme, C.I., and Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press, San Diego, CA, USA.576p.

34 Richardson, A.J., (2008). In hot water: zooplankton and climate change. ICES Journal of Marine Science, 65(3), pp.279-295.

35 Ridgway, S.H., Wever, E.G., McCormick, J.G., Palin, J., Anderson, J.H., (1969). Hearing in the giant sea turtle, Chelonia mydas. Proc Natl Acad Sci USA 64:884-890. pmid:5264146

36 Rolland, R.M., Parks, S.E, Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S.K. and Kraus, S.D. (2012). Evidence that ship noise increases stress in right whales. Proceeding of the Royal Society of Biological Sciences, 10. 1098/rspb. 2011. 2429

37 Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.G., and White, P. (2016). Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Sci. Rep. 6, 20540; doi: 10.1038/srep20540

38 Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr, C.R., Kastak, Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33: Number 4. [online] Available at: http://sea-inc.net/assets/pdf/mmnoise_aquaticmammals.pdf (Accessed March 2019)

39 The University of Rhode Island (2017). Discovery of Sound in the Sea (DOSITS). Behavioral Changes in Fishes. [online] Available at: https://dosits.org/animals/effects-of-sound/potential-effects-of-sound-on-marine-fishes/behavioral-changes-in-fishes/ (Accessed March 2019)

40 Tidau, S., and Briffa, M. (2016). Review on behavioural impacts of aquatic noise on crustaceans. Conference Paper in Proceedings of meetings on acoustics. Acoustical Society of America – December 2016. DOI: 10.1121/2.0000302

41 Visser, A.W., 2007. Motility of zooplankton: fitness, foraging and predation. Journal of Plankton research, 29(5), pp.447-461.

42 Wyatt, R. (2008). Review of existing data on underwater sounds produced by the oil and gas industry. Oil and Gas Producers (OGP) Joint Industry Programme report on Sound and Marine Life.

Appendix D

NPWS meeting minutes

Minutes

ARUP

Project title	Greenlink	Job number 246369-00	
Meeting name and number	NPWS Meeting	File reference 9-04	
Location	NPWS, Custom House, Galway	Time and date 2.30pm	9 December 2015
Purpose of meeting	Discuss potential landfall options and environmental studies for the Greenlink Interconnector (DAU Ref: G Pre00357/2015)		
Present	NPWS - David Lyons Element Power - Tom Brinicombe Intertek - Anna Farley (Offshore consultant) Arup - Sheila O'Sullivan (Onshore consultant)		
Apologies	Connie Kelleher & Karl Brady (National Monuments Service - DAHG)		
Circulation	Those present		

Action

1. Introductions

David Lyons will be the NPWS point of contact for the project. David will deal with the offshore scope of work. Somebody else from NPWS will be appointed for the onshore scope of work when required at a later date in the project.

Tom Brinicombe represents the client of the project – Element Power.

Intertek are the offshore consultant for the project.

Arup are the onshore consultant for the project.

2. Project Overview

The Greenlink project is proposing to develop a 500MW interconnector between Ireland and the UK.

The project will link the power markets in Great Britain and Ireland.

Prepared by	Sheila O'Sullivan
Date of circulation	6 January 2015
Date of next meeting	N/A

Action

The current proposed connections are Pembroke in Wales and Great Island in Ireland.

Greenlink has obtained EU CEF (Connecting Europe Facility) funding to the end of next year.

Greenlink is also expected to be confirmed as an EU PCI (Project of Common Interest) early in 2016.

3. Draft Landfall Options & Environmental Constraints

A preliminary desk-top assessment & preliminary site visits have been completed to identify potential draft landfall options for the interconnector.

The shortest route corridor is preferable both from an economic point of view and an environmental point of view as it minimises potential impacts – therefore the preliminary assessment has focused on the southeast of Ireland.

The location of the landfall also requires a compromise between onshore and offshore constraints.

The southeast coast of Ireland is protected by numerous offshore environmental designations, including SAC's and SPA's and therefore create an environmental constraint to the landfall location.

While assessment work is an iterative process, the following three landfalls have been identified as preferable based on draft preliminary assessments:

- Booley Bay
- Boyce's Bay
- Baginbun Beach

Booley Bay landfall is located within the River Barrow and River Nore SAC.

Boyce's Bay landfall is location within the Hook Head pNHA.

Baginbun Beach is located within the Hook Head SAC.

Habitat maps and conservations area files are available on the NPWS website.

Booley Bay is located in close proximately to a very important subtidal reef within the River Barrow and River Nore SAC (Duncannon). DL noted the exact boundary of the reef in relation to the landfall and any potential impact should be assessed. Mitigation — AF

Action

to be considered would include reinstating the top layer of the trench.

DL noted the pNHA's do not have protected status.

Summer installation would be preferable to avoid disturbance to the kittiwake colony in the Hook Head pNHA. Geese feed regularly on the shores in winter.

DL noted that the route and landfall locations within designated sites are acceptable once it can be demonstrated that there would be no negative impacts to the designated sites.

The Hook Head SAC is a rocky habitat and potential installation methodology would have to be assessed. DL noted it is preferable to use trenching or horizontal directional drilling under the designated sites rather than mattressing and/or rock protection, due to potential impact to the designated site and habitats with rock protection.

The offshore geophysical and geotechnical surveys will confirm the potential cable route installation methodology. Following confirmation of potential installation methodologies an assessment on potential impacts to the designated sites will be completed to evaluate suitability.

The installation is a relatively quick process and therefore potential impacts and mitigation for birds etc. are anticipated to be suitable for the environmental assessment.

Migratory fish species are designated features of the River Barrow and River Nore SAC. DL felt that the geophysical survey and installation would not prove to be a barrier to passage and no specific mitigation would be required.

DL noted that the estuary comprises of a sandy sediment top layer which should be suitable for installation. Within the estuary disturbance of the upper sandy sediment layers is common and therefore the quick installation is anticipated to create no significant impact with high recoverability of the seabed.

The SPA is a Ramsar site – DL to confirm. DL

4. Offshore Survey, Foreshore Licence & Environmental Constraints

A geophysical survey and geotechnical survey are proposed for the offshore route.

	Action
Pre-application has been prepared for the foreshore licence with will be submitted in the near future. DL confirm the DECLG Foreshore department will review this documentation.	
DL noted that the geophysical and geotechnical survey application should be completed together as for ease of NPWS assessment and approval.	
The actual application will be issued to the NPWS (DL) via the DECLG Foreshore department. DL noted all available information should be included within the application.	
It will take approximately 8 weeks to approve the licence once all information is submitted.	
A screening for appropriate assessment and a Marine Mammal Assessment will be required for the foreshore licence for the offshore survey.	AF
As it is a generic survey preliminary information is ok as it is understandable that the actual route is not confirmed and will be modified as results are gathered.	
It was agreed that a 1km wide corridor will be submitted to ensure all areas are covered within the application; however, it is anticipated that the survey will only require an approximate 500m wide corridor.	
It is anticipated that Multi-Beam Echo Sounder, Sidescan Sonar, Sub bottom profilers, magnetometers will be used for the survey.	
DL noted that a marine mammal observer will be required onboard for startups and works to be completed in accordance with the ‘Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters’. DL highlighted the main concern for marine mammals would be the effect from sub bottom profilers in an embayment. DL outlined the area he considered to be an ‘embayment’ in the vicinity of the landfall locations.	
The River Barrow and River Nore SAC are protected for lamprey and salmon. DL noted this will not be an issue for the survey as noise levels created will not be significant and works also will be within a small area therefore not creating an obstacle. This will be similar for the cable installation.	
Intertek will issue actual GIS ArcView information to the NPWS, however, this will not be submitted to the Foreshore Department as not required for their systems.	

5. Proposed Surveys & Studies

A separate screening for appropriate assessment (and potential Natura Impact Statement) and Environmental Report will be prepared for the actual cable installation. It is anticipated that a full EIA will not be prepared. A screening for EIA will be completed.

The offshore surveys proposed are as follows: Archaeological assessment, Marine Mammal Risk assessment, Marine Surveys (as detailed in Section 4 above), Intertidal Survey, and UXO survey.

Standard onshore (terrestrial) surveys will be completed. These will be discussed with onshore NPWS representative at a later date.

The standard onshore environmental studies anticipated are as follows: Flora & Fauna, Archaeological / Cultural Heritage, Geotechnical, Traffic, Noise, Air Quality, Flood, and Landscape & Visual.

The standard onshore ecological surveys anticipated are as follows:

- Winter Birds (landfalls)
- Breeding Birds
- Bats
- Badgers
- Otters
- Other Mammals
- Hedgerows & trees

6. Any other business

DL noted that more information may be available for the offshore marine routes from the Infomar website (geophysical data particularly should detail the sand-waves etc.)

There are no offshore marine protected sites (beyond the foreshore).

DL noted offshore Wexford is a busy fishing area with lots of trawling offshore.

Cable protection will be very important (particularly as High Voltage cable) to ensure no impacts to the cable but also to the fishing industry.

Meeting no.	02
Type of meeting	Consultation on Greenlink interconnector
Date	13/03/2018
Time	14:00 – 15:00
Location	Foreshore Unit, Wexford

Attendees	In person		
		Tom Brinicombe Anna Farley David Lyons	Element Power – Development Manager Intertek – Project Manager NPWS

Minutes

Item	Minutes	Actions
1	TB provided update on project programme. • Marine surveys planned for summer 2019 • Public consultation on onshore scope planned for April 2019 (*since delayed to May 2019)* Discussed maximum converter station sizes and how these will be presented to public e.g. maximum dimensions with then scope to reduce during actual construction.	
2	AF provided update on status of Foreshore Licence application (public consultation ended). Responses received from majority of consultees. Specifically mentioned concerns raised by Inshore Fisheries Ireland (IRI) as it relates to SAC designated features. DL advised that IFI are more used to commenting on blasting / seismic surveys applications and it is possible that they are unfamiliar with the scale of the geophysical survey proposed and therefore have not adapted advice. AF may need to explain underwater sound levels expected are similar to a fish finder.	
3	**Baginbun Beach route through Hook Head SAC.** Presented maps (linked below) showing slight route revisions planned to avoid rock outcrop on beach approach. Showed route in relation to sensitive site features highlighting plans to avoid sampling sensitive features. NPWS_Mar18.pdf NPWS_2_Mar18.pdf DL commented that in his opinion burial in a sand channel within the SAC would only have an ethereal impact, with pre-impact conditions reached within 6 months. He didn't see any issue with the route.	
4	**Marine mammals** Greenlink will be using a marine mammal observer within the embayment for the geophysical survey. Reiterated commitment to follow the Guidelines. DL commented that for installation it is possible that the area considered an embayment could be reduced (due to the lower underwater noise changes associated with installation), and an MMO out to 1km may be sufficient.	

Actions

Item	Action	Delegate
	No actions arising from meeting	

Meeting no.	26
Type of meeting	Consultation on Greenlink interconnector
Date	07/02/2019
Time	14:00 – 15:30
Location	NPWS, Druid Land, Flood Street, Galway

Attendees	In person	Anna Farley	Intertek – Offshore Project Manager
		Tina Raleigh	Greenlink Interconnector Limited – Irish Consents Manager
		Daniel Garvey	Arup – Onshore Project Manager
		Karl	Arup – Onshore Ecologist
		David Lyons	NPWS – Marine Advisor
Distribution		As above & Tom Brinicombe (Greenlink Interconnector Limited)	

Agenda items

Item	Brief description/ background	Lead
1. Project Update	▪ Objective is to provide update on marine survey progress, introduce the Campile Estuary Crossing, and discuss the NIS.	AF

Minutes

Item	Minutes	Actions
1	AF talked group through the attached slide pack. Slides provide: • An update on the project timelines; • Short background on how & why the Baginbun Beach route has been selected as the preferred offshore route; • Overview of preliminary survey data acquired within Hook Head SAC (SSS, MBES, grab sample locations, seabed photos) • Introduction of Campile Estuary HDD crossing (description of works, description of environmental sensitivities). • Summary of the Environmental Impact Assessment Report (EIAR) scoping process and responses received to date; • Outline of impacts to be scoped in and out of the EIAR; and • High level description of installation process and pre-installation seabed preparatory works. NPWS meeting 20190207.pdf	
	Maritime Bill. • Held up by political process. There are some concerns that County councils do not have the resources to fulfil the requirements under the Bill. It is unlikely to come into statute before 2020. **HDD at Baginbun and use of anchors** • AF explained that Intertek and Arup are currently discussing whether the Baginbun HDD can be extended to closer to the 10m contour as this would mean that potentially an anchored barge would then not be required for installation. AF asked whether there would be any concerns about using anchors within the SAC. • DL responded that use of anchors was a temporary interaction with the structure and function of the reef features within Hook Head SAC and that it	

Item	Minutes	Actions
	was within the envelope of normal activities expected within the SAC and would not be considered a problem. **Benthic survey** • DL - asked whether it was a requirement for underwater photography in Wales. • AF – not a statutory requirement but done as best practice to support interpretation of benthic grabs and geophysical data. • AF – photography in Hook Head SAC showed high turbidity due to previous storm conditions, which fitted with anecdotal evidence of typical conditions for the site. • DL - for biotope assessment EUNIS level 4 would be sufficient. • DL – photographs would be useful in supporting NIS assessment of effects from trenching. Also consider the hydrodynamics in the site (wind & tidal flow data will be publicly available) and presence of fine sediments to support assessment. Ensure that assessment refers back to the conservation objectives of the site. If assessment identifies the need for mitigation one example to consider is water sampling to monitor turbidity levels.	
	NIS • DL's recommendation would be to compile one NIS that included the entire Project from converter station to converter station. By having individual NISs to support the planning applications there is the risk that GIL could be accessed of 'project splitting'. One all-encompassing NIS would alleviate this risk' although DL acknowledged that it would make his job slightly harder to review when it came to assessing the Foreshore Licence application. • NIS should also ensure that Annex I species are considered and appropriately written up even if there is no effect to show that they have been included in the assessment. • DL - noted that Great Northern Diver had been observed at the site. The species is seen to be sensitive and would probably need mitigation. • DL - ensure that the NIS framed the examination around the conservation objectives of the sites. • DL – ensure that the NIS takes into consideration all recent case law. • DL - with the recent CJEU rulings on the Habitats Directive permanent loss of habitat no matter how small would be considered significant. • DL - thought there was more recent guidance on NIS and Habitats Directive Article 6 available for the European Commission (November 2018).	20190207-01
	Marine mammals • DL – Didn't think that marine mammals would be effected by the installation activities, Vessel move too slowly to be of concern. Grey seals are likely to be in the area due to the presence of haul-outs at Saltee Islands. However, grey seal are unlikely to be disturbed. There is anecdotal evidence from dredging activity at Rosslare that harbour porpoise favour dredge area as the sediment plumes masked their hunting activity and prey didn't see them coming. Suggested AF contacted Brendan O'Connor at Aquafact for information if interested. **Invasive Species** • DL interested that Wales require assessment of invasive non-indigenous species and will be interested in seeing the assessment once complete in the Irish EIAR.	

Actions

Item	Action	Delegate
20190207-01	GIL, Intertek and Arup to discuss feasibility of compiling one NIS for the entire project (i.e. converter station to converter station) taking into consideration programme and legal review.	AF / DG / TR