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Morlais Project
Environmental Statement

Chapter 3: Site Selection and Consideration of Alternatives

Volume I

Applicant: Menter Môn Morlais Limited

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Chapter 3: Site Selection and Consideration of Alternatives

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GLOSSARY OF ABBREVIATIONS

DP	Dynamic Positioning
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEED	Front End Engineering and Design
GBS	Gravity Based Structures
HDD	Horizontal Directional Drilling
km	Kilometres
kV	Kilo volts
LAT	Lowest Astronomical Tide
MDZ	Morlais Demonstration Zone
MW	Megawatts
NRW	Natural Resources Wales
O&M	Operation and Maintenance
PDE	Project Design Envelope
RLB	Red Line Boundary
rpm	Rotations per Minute
TEC	Tidal Energy Converters
TWAO	Transport and Work Act Order
UKC	Under Keel Clearance

GLOSSARY OF TERMINOLOGY

Axial Flow	Horizontal axis rotors.
Category 1 tidal device	Seabed Mounted Sub-Surface Tidal Devices.
Category 2 tidal device	Buoyant Mid-water Column Tidal Devices.
Category 3 tidal devices	Floating and / or Surface Emergent Tidal Devices.
Cross Flow	Vertical axis rotors.

3. SITE SELECTION AND CONSIDERATION OF ALTERNATIVES

3.1. INTRODUCTION

1. Menter Môn Morlais Limited (hereafter referred to as Menter Môn) proposes the development of 240 MW of tidal generating capacity within the Morlais Demonstration Zone (MDZ). Development of the Morlais Project (the Project) will support the objectives of the Anglesey and Gwynedd Joint Local Development Plan (JLDP), aimed at promoting the development of renewable energy technology. The Project will prioritise the maximisation of opportunities for local communities directly via employment and indirectly via the establishment of a local supply chain. Through development of the Project, Menter Môn seeks to establish Anglesey as a marine energy hub.

2. The development of the Project will provide a consented tidal technology demonstration zone, specifically designed for the installation and demonstration of arrays of tidal energy devices (tidal devices). The Project will provide communal infrastructure to its tenants, tidal technology and project developers, enabling a shared route to grid connection using the Project's export cables, Landfall Substation, onshore cable route and Grid Connection Substation.

3. Details of the infrastructure that forms the Project and is considered in this ES, are provided in **Chapter 1, Introduction** and in **Chapter 4, Project Description**.

4. This chapter summarises the site selection process for the Project, including the background to selection of the MDZ, tidal devices, the offshore cable route, cable landfall location, landfall substation location, the onshore cable route, Switchgear Building location and the Grid Connection Substation location.

5. This chapter presents an overview of the decision-making process for each element of the project outlined above and is separated in to these discrete sections. However, note that these aspects are often interrelated and were undertaken in a parallel and iterative basis, rather than sequential approach. For example, selection of the landfall substation location was based on an overview of onshore constraints but also took into consideration the outcomes of the assessment of offshore export cable corridor and cable landfall point locations.

6. The broad process of project selection is outlined in **Plate 3-1**. The processes are iterative, ensuring that the ES chapters inform the decision-making process.

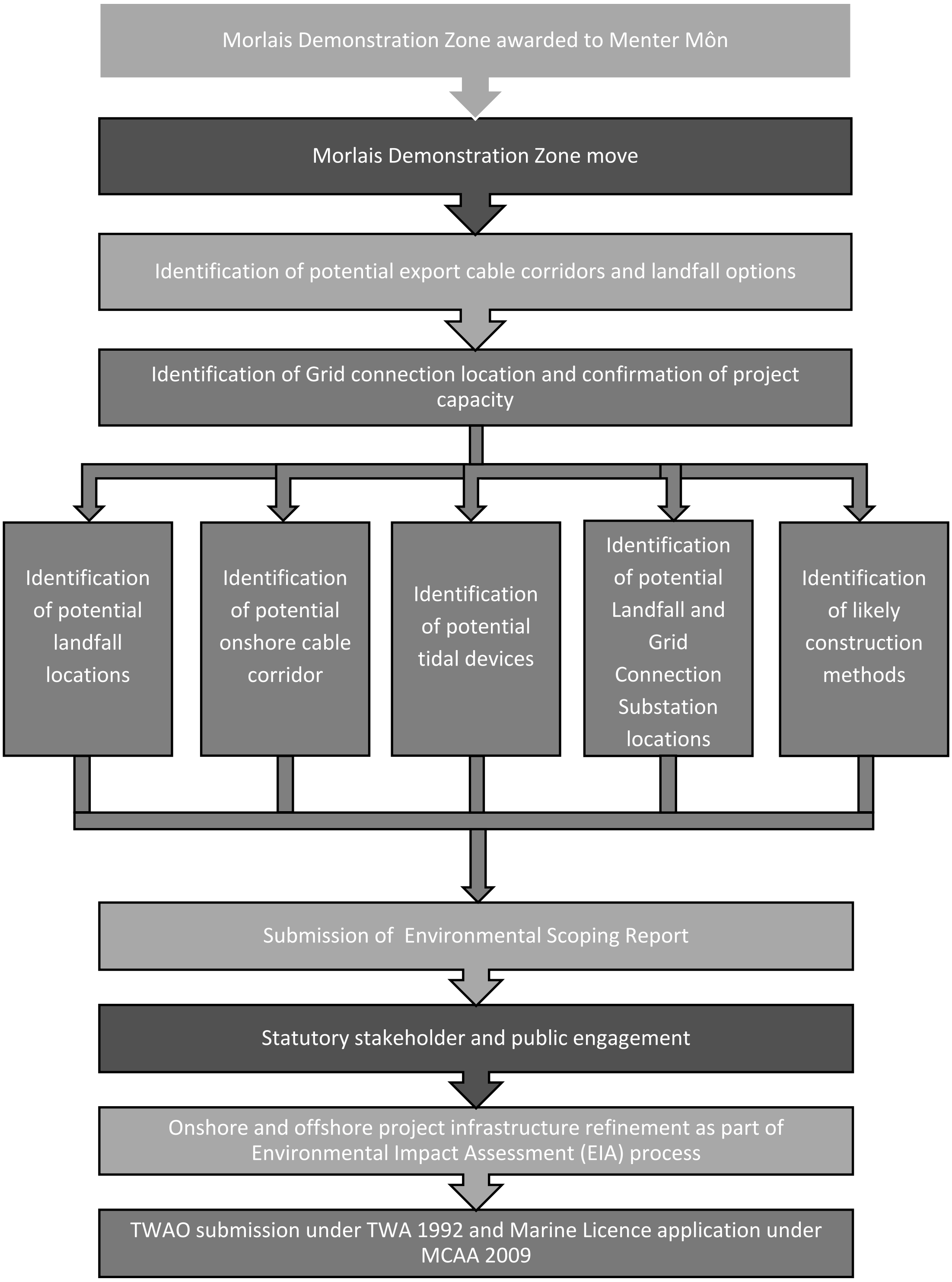

Plate 3-1 Site selection process for the Project

3.2. LEGISLATION AND GUIDANCE

3.2.1. Environmental Impact Assessment Regulations

7. The consideration of alternatives and major design decisions made during the development of a project has been part of Environmental Impact Assessment (EIA) legislation since the adoption of the original European Union (EU) EIA Directive 85/337/EEC in 1985 (as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC) and is also included within amended Directive 2014/52/EU.

8. The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017 and The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2016 provide the following description of what should be included within the Environmental Statement (ES); "*A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects*."

9. The Transport and Works (Applications and Objections Procedure) (England and Wales) Rules 2006 amend the wording slightly but do not significantly change the position. The legislation requires an ES to include "*an outline of the main alternatives to the proposed works studied by the applicant and an indication of the main reason for his choice, taking into account the environmental effects*".

3.3. WHY ANGLESEY?

10. The United Kingdom (UK) has the largest wave and tidal resource in Europe. The Marine Renewable Energy Strategic Framework (MRESF), found a potential for 1.5 to 6.5 GW of installed capacity in Welsh waters (Regeneris, 2013). **Chapter 1, Introduction** provides an overview of the tidal resource of the UK.

11. The MDZ is one of several development areas around the UK which have been identified by The Crown Estate (TCE) in a bid to encourage and accelerate technology development. Each area was identified because it offered appropriate wave and tidal energy potential, as well as access to necessary infrastructure, including ports and electricity grid.

12. The MDZ is an area of 35 km^2 located west of Holy Island, itself off the west coast of the Isle of Anglesey. The MDZ is approximately 7 km from north to south and 5 km from east to west, with the eastern boundary less than 1 km from shore at its closest point. The strength of tidal flow varies across the site with higher levels experienced to the north of the MDZ and in those parts of the MDZ closest to the coast of Holy Island.

13. The MDZ has a mean and maximum water depth of 38.4 m and 80 m, respectively. A mean spring peak velocity (V_{msp}) was estimated by TCE to be 1.7 m/s. Other sources estimate peak spring tide currents (V_{pk}) in excess of 2.5 m/s across large areas of the region (Piano *et al*., 2015), with the potential to reach accelerated flows of up to 3.1 m/s V_{msp} in some parts of the MDZ. The highest velocities within the MDZ are recorded just off Holy Island (4.0 m/s) (see **Chapter 7, Metocean Conditions and Coastal Processes**).

14. A feasibility study commissioned by Isle of Anglesey County Council (IoACC) (Feasibility Study for a Marine Energy Programme – a Marine Energy Sector Development Programme 2013) described the marine energy sector as "*a major opportunity for transformational economic growth*" for North Wales and recognised the importance of "*supporting and encouraging local marine skills capability and supply chain capacity…to create positive regional impacts and benefits*."

15. In pursuit of this commitment, IoACC established The Anglesey Energy Island Programme, a collective effort between several stakeholders within the public, private and third sectors working in partnership, putting Anglesey at the forefront of low carbon energy research and development, production and servicing, and bringing with it potentially huge economic rewards.

16. Energy Island's vision is to create a once-in-a-lifetime opportunity for jobs, economic growth and prosperity through capitalising on a number of transformational projects on Anglesey. The Energy Island Programme collaborates with a number of key stakeholders to:

- Attract and de-risk major strategic investment;
- Influence potential developers;
- Support development of competitive people and communities;
- Support development of competitive businesses;
- Support development of competitive infrastructure;
- Realise the benefits major projects can bring and mitigate adverse impacts; and
- Maximise long-term legacy benefits.

17. The developer, Menter Môn, is a not for profit social enterprise company providing solutions to the challenges facing North Wales. Menter Môn has a strong local presence on Anglesey and a passion for developing renewable energy on the Island, and to increase and diversify employment and economic development opportunities.

3.4. PROJECT ALTERNATIVES

18. A number of alternatives have been considered as part of the decision-making process. The early strategic project consideration of alternatives which fed directly into the site selection process are detailed in **Table 3-1**.

Table 3-1 Outline of Alternative Considerations and Final Selection

Topic	Consideration of alternatives	Final selection for the Project
Project size	The initial project concept had a capacity of less than 100 MW. However, the availability of tidal resource (velocities between 2.2 to 2.8 m/s across most of the site, with peak of 4.0 m/s) across the MDZ, updates in technology and increased interest from tidal device developers for deployment in the MDZ led to an increase in the proposed installed	The final capacity for the Project to be applied for consent is 240 MW.

Topic	Consideration of alternatives	Final selection for the Project
	capacity, initially to 180 MW and now to 240 MW.	
MDZ location	A review of the baseline metocean conditions highlighted that the tidal range across the MDZ is variable and is greater to the north and east of the MDZ. Shortly after appointment of Menter Môn as managers of the MDZ by TCE, Menter Môn requested to TCE that the MDZ be moved north, so as to include more areas of greater tidal resource.	Menter Môn consulted with marine stakeholders on the request to move the MDZ north. TCE subsequently agreed to the request.
Tidal devices	A wide variety of devices was initially proposed as providing exemplars to define the design envelope for the Project. The list of devices considered was revised to allow for removal of devices for which insufficient information was available to allow definition of design parameters.	12 shortlisted devices (those with sufficient information from developers), were used to define this aspect of the project design envelope. The tidal devices have been placed into categories depending on their scale, and their position in the water column (see **Section 3.8.1**).
Export cable corridor	An area from Holyhead to Trearddur Bay was analysed to identify suitable landfall points and substation locations. An initial review of the baseline physical environment by Menter Môn identified that cable burial would not be possible throughout the majority of the potential export cable corridor.	A variety of alternative cable laying options was reviewed due to the existing geomorphological conditions. This will be refined post submission; however, a worst-case scenario forms the basis of the Morlais ES (**Chapter 4, Project Description**).
Landfall area	A long list of 15 landfall areas with a variety of construction techniques was reviewed for suitability to the variable Holy Island coastline.	Landfall sites were shortlisted on the basis of a number of considerations including, nature conservation designations, existing infrastructure, feasibility of construction, seabed suitability for cable laying and length of export cables.
	A short list of four landfall locations within the Abrahams Bosom area of west Holy Island were selected for further investigation. Due to the cliff and foreshore geology, a range of construction techniques were reviewed.	Key receptors included noise and visual disturbance to residential properties adjacent to the landfall site, and minimising disturbance to both ecological designations, foreshore and cliff line within Area of Outstanding Natural Beauty (AONB) and Heritage Coast. Options for split pipe cable laying within trenches, and Horizontal Directional Drilling (HDD) were identified.
Landfall Substation	A long list of 13 landfall substation locations was considered. Landfall substation locations were shortlisted based on a number of considerations, including nature	A final site was chosen based on further consideration of nature conservation designations and landowner discussions. Further consideration of potential visual impacts results in the position of the Landfall Substation within

Topic	Consideration of alternatives	Final selection for the Project
	conservation designations, existing infrastructure and potential visual impacts. Key considerations were the feasibility of landfall construction using the preferred trenching and HDD methods, and the distance of the Landfall Substation from the landfall. A short list of four options, within Abrahams Bosom were selected for further investigation.	a recessive location in the landscape and uses the landform to help integrate the substation into the landscape.
Grid connection point	The closest four options to the project site were considered. Those were refined to the three closest, with two on Holy Island to minimise disturbance during cable trenching works; one at the Parc Cybi employment site and one at the existing Anglesey Aluminium and Orthios site.	The preferred location for connection to the existing electricity network, for the full 240 MW installed capacity, is the Grid Connection Substation at Orthios. This is due to the proximity to an existing substation for minimising visual impacts, technical considerations and the use of land within a brownfield site, in order to minimise disturbance to onshore ecology and local residents.
Switchgear station	The location of a substation at Parc Cybi was considered as one of 4 grid connection point options (above).	The 33 kV connection point at 'Parc Cybi' is selected as a suitable location for a switchgear building. This offers connection of early phases of the Project to the local electricity network, whilst the 132 kV grid connection point 'Orthios' is connected to the national transmission network.
Onshore cable route	Given the rural nature of the project, the location of the AONB, public perception and consultation with IoACC, it was decided that overhead cables would not be appropriate. Only options for traditional trenching methods of cable installation between the Landfall Substation and Grid Connection Substation were reviewed.	The final onshore cable route is selected to minimised disturbance to the natural environment on Holy Island. Therefore, the onshore cable route will be of up to 8.1 km total route length, dependent on final detailed route design, with the cables trenched into the local road network so much as is practicable given constraints in road width and services already within the road. The final cable corridor and proposed route is presented in **Chapter 4, Project Description**.

3.5. SITE SELECTION PROCESS

19. The siting, design and refinement of the Project has followed a site selection process, taking account of environmental, physical, technical, commercial and social considerations and opportunities, as well as engineering requirements. The aim has been to identifying sites that will be environmentally acceptable whilst also being technically and financially achievable. A multi-disciplinary design team was formed to undertake the site selection process, which included engineering and EIA consultants.

20. Menter Môn has undertaken extensive pre-application engagement with stakeholders, communities and landowners in order to refine the final project design, and to communicate decisions made to achieve those refinements.

21. Consultation and refinements to project layout and configurations has been undertaken since Menter Môn Cyf had been awarded the right to manage what was then known as the West Anglesey Demonstration Zone (WADZ) in July 2014. Further details of consultation are outlined in **Chapter 6, Consultation** and described in detail in the Consultation Report (**Document MOR/RHDHV/DOC/0066, Consultation Report**). In summary, mechanisms used to refine the project have included:

- Drop in Exhibitions held at locations within and adjacent to the Onshore Development Area;
    - First Public Information Day (PID) held on the 19th March 2019; and
    - Second PID held over three sessions on 11th, 12th and 17th June 2019.
    - Feedback from each group at the PIDs is incorporated into the Consultation Report (Document MOR/RHDHV/DOC/0066, Consultation Report) and used in the relevant receptor impact assessments, as well as being outlined in the ES.
- Community engagement events, focussing on town and community councillors;
- Engagement with relevant local authorities, landowners, community councils and other local stakeholders, in order to raise awareness of the Project, to outline the consenting process and to highlight opportunities to input to proposals.
    - Consultation has been undertaken directly with landowners and interested parties including tenants, occupiers and other parties with land rights. Engagement with individual land owners within or adjacent to the proposed development was managed directly by Menter Môn, with support from their appointed Land Agent. Letters were sent to all potentially affected parties offering to meet to discuss the project proposals;
- Menter Môn's land agents have contacted the affected landowners. A number of onshore cable route change suggestions have been put forward by those affected by the red line boundary (RLB). Menter Môn have been able to incorporate a number of those suggestions into the final design of the Project. Newsletters distributed throughout the Scoping Area, as described in the Consultation Report. These newsletters were distributed prior to each PID event; in March and June;
- Leafleting relevant communities to 'capture' hard to reach groups;
- Provision of a dedicated project website; and
- Regular and targeted discussion with regulators and other stakeholder bodies through various means including Technical Working Group meetings, where the siting of project infrastructure was discussed in detail. More information is provided in **Chapter 6, Consultation**.

22. In addition to the consultation activities presented below, Menter Môn met with the Planning Inspectorate and IoACC's Planning Officer on a regular basis throughout the development of

the Project, to provide updates and to seek advice on subjects including the site selection process, approach to the EIA and drafting the application documents.

3.6. DEFINING THE SCOPING AREA

23. The initial offshore scoping area followed the boundaries of the MDZ. The onshore scoping area encompassed the location of all landfall, substation and cable route options being considered, including appropriate buffers around each location (minimum of 500 m around landfall and onshore substation locations and 300 m around onshore cable routes). The buffers applied include all areas required for temporary construction.

24. The scoping area around the potential onshore infrastructure locations was developed to identify sensitive receptors likely to be present a distance of the development where they are likely to receive impacts. For most receptors, physical disturbance is likely to be a key consideration. Disturbance from noise is also likely to be a key consideration, particularly to ecological and human receptors.

25. Onshore construction works will be restricted to the footprint of the substations and onshore cable routes, plus an appropriate buffer, ensuring that physical disturbance is localised.

26. Noise receptors within 500 m of the substation are likely to be most impacted, although potential for impacts to occur beyond 500 m will also be considered within the EIA.

27. Potential for visual impact over a far greater area exists and zones of theoretical visibility (ZTV) were used to define the potential scale of impacts.

28. Terrestrial ecological receptors are anticipated to be less sensitive to cable installation, and a 300 m buffer was used for identifying sensitive receptors for this reason. The potential to impact on receptors further than 300 m away will also be considered in greater detail during the EIA.

29. Following the definition of the offshore project area, site selection for all other infrastructure was assessed in a strategic manner such that the areas identified would be sufficiently assessed and to allow for site refinement.

30. A number of external studies were commissioned by Menter Môn, including the following;

- Cable Routing Report (ITP Energised Ltd. (ITPE), 2018a);
- Device Developer Consultation Report (ITPE, 2018b);
- Generation Connection Options (Sustainable Electrical Supply Ltd. (SESupply) 2016;
- Morlais Above Ground Landfall construction options (ITPE, 2017);
- Preliminary Design Options Report (ITPE, 2018c); and
- Substation Location Feasibility Study (ITPE, 2016d).

31. The outputs of these technical studies are provided in sections (**Section 3.9.1** to **Section 3.12**).

32. Utilising the details within these technical studies, a Front-End Engineering Design (FEED) study was undertaken by ITP Energised (ITPE) on behalf of Menter Môn in 2017, to provide the

proposed design of the project necessary to inform the EIA project description for consent **(Appendix 4.1, Volume III)**. Further to a revision of proposed installed project capacity to 240 MW, an addendum to the study was undertaken for the MDZ elements **(Appendix 4.2, Volume III)**, also by ITPE. In parallel, Black and Veatch Ltd. (B&V) have been responsible for further design of, and updates to, the onshore infrastructure within the ODA.

3.7. IDENTIFICATION OF THE MORLAIS DEMONSTRATION ZONE

33. TCE's site selection process began in 2013 with the identification of 11 wave and tidal energy demonstration zones. The MDZ was identified as being a suitable location for the installation of tidal devices in the short to medium term, having a good tidal current resource, over a relatively uniform water depth to seabed and a relatively low wave regime.

34. TCE undertook extensive consultation with marine user groups during the process of demonstration zone identification and a competitive leasing process was then undertaken to identify suitable locally based organisations to manage and sub-let the sea bed within each of the zones.

35. In July 2014 TCE announced that Menter Môn had been awarded the right to manage what was then known as the West Anglesey Demonstration Zone (WADZ), and to sub-let use of the seabed to other bodies who could take forward the development of tidal technology in the UK. The WADZ is described in this ES as the Morlais Demonstration Zone (MDZ).

36. After an assessment of the distribution of tidal stream resource within the MDZ, in 2015, Menter Môn applied to TCE for the movement of the MDZ further to the north, to better capture the main areas of significant tidal stream flow to the west of Anglesey. Menter Môn consulted stakeholders on the proposed move and TCE approved the change in 2016.

3.8. IDENTIFICATION OF TIDAL ENERGY DEVICES

37. In order to understand the potential consent requirements for the project and the design envelope needed, it was necessary to identify the potential tidal devices which could be deployed within the MDZ.

38. A detailed review of the device types and technologies with realistic potential to be deployed in the MDZ was undertaken. A key objective of this review was to allow the Project Design Envelope to be defined to encompass a realistic range of tidal devices and technologies.

39. A number of tidal technology developers were contacted, either those expressing an interest in the project, or those whose technologies were considered to be potentially available at the time of the Project's construction.

40. The developers contacted were

- Andritz Hydro Hammerfest;
- Aquantis;
- Atlantis Resources Corporation;

- Instream Energy Systems;
- Magallanes;
- Nova;
- OpenHydro (now no longer trading);
- QED Naval;
- Renewable Devices;
- Repetitive Energy;
- Sabella;
- Orbital Marine Power;
- TidalStream (Schottel Hydro);
- Tocardo;
- Verdant Isles;
- Hydroquest; and
- Big Moon.

41. Consultation was undertaken to obtain information on the technical data of the devices, infrastructure requirements, and deployment, operation and maintenance requirements. Other objectives included obtaining an understanding of the approximate deployment timescales and phasing options and the power output characteristics to inform grid connection studies. A number of parameters were discussed and are summarised in **Table 3-2**.

Table 3-2 Design Considerations of Potential Tidal Devices to Inform PDE Development

Component	Design Considerations
Timing	Planned installation dates and phasing
	Length of deployments
Subzone layout	Number of devices
	Device spacing and potential layout of devices and infrastructure within the sub-zone
	Aggregation strategy
	Connection to transmission infrastructure
Device design	Device size
	Device configuration (axial/transverse/other)
	Surface piercing/floating/sub surface
	Foundation/mooring type and design (GBS/piled)
	Footprint of deployment
	Blade number, dimensions and rotation speed
	Electrical output – rated capacity and voltage; and import power requirements
	Control strategy including location of converters
	Communications and electrical isolation methodology
	Structure and materials

Component	Design Considerations
	Fluids on board and potential discharges
Installation approach	Duration and seasonality of offshore installation activity
	Installation equipment and vessels to be used
	Methodology
	Port requirements
	Hard standings and road access
Operational and maintenance considerations	Personnel and vessels required
	Frequency of scheduled maintenance interventions
	Frequency and type of scheduled surveys
	Unscheduled maintenance
	Back-up electricity supply requirement
	Port requirements
Decommissioning	Approach to decommissioning

3.8.1. Device Selection Methodology

42. A range of devices were identified during the initial consultation, from axial flow and cross flow turbines to turbine neutral platforms. The largest devices are 2 MW, and the smallest are between 50 kW and 100 kW. Rotor sizes vary between 5 m and 27 m in diameter. Some developers have a design employing more than one rotor on their structure. The average speed of TEC rotation considered within the Project Design Envelop (PDE) is between 7.5 and 26.7 rotations per minute (rpm).

43. Some developers would deploy surface emergent technology at the site. Whilst some require deep water (greater than 40 m), others would prefer shallower areas for deployment. Three foundation/mooring types are required: gravity base systems, drilled monopile and driller multi-pin pile.

44. The footprint of deployment varies significantly between developers, with single, bottom mounted turbines requiring a smaller seabed area per device (<300 m^2) in comparison to floating devices with a 'Swept Area' (area that could be subject to mooring line drag) up to 1,000 m^2 per device, in some cases.

45. Based on the information gained, significant consideration has been given to those device types which would be least likely to have an adverse effect on the particular site sensitivities (i.e. visual impact, collision risk to marine mammals and birds). There is a wide range of novel device types available; however, in order to achieve a meaningful impact assessment, some limitations were imposed. The typical, as well as the ‘worst case’, parameters for all of the devices are summarised in ITPE’s Project Design Envelope Definition report to Menter Môn (ITPE, 2018c).

46. A number of device categories were excluded from further consideration due to technology status, or wider potential consenting risks. Those categories included;

- Surface emergent, seabed mounted tower;
- Large seabed mounted cross flow, horizontally orientated;

- Ducted cross-flow; and
- Other 'novel' designs.

47. The devices to be included within the Project Design Envelope have been categorised into three categories: seabed mounted devices, mid-water column devices and surface emergent / floating devices. Devices in each category can support single or multiple tidal energy converters (TEC), with those TECs potentially being of a horizontal axis, or vertical axis form. The categories are described in more detail in **Chapter 4, Project Description**, however, the following key elements are common across the device types:

- Foundation or anchors on the seabed;
- A supporting substructure;
- A Tidal Energy Converter (TEC);
- Seabed preparation; and
- Cable connections.

48. Further detail on the device types is included in **Chapter 4, Project Description**. The device types assessed in this EIA, are deemed to represent the most realistic worst case device parameters for deployment at Morlais. Any device types which are not encompassed by the Project Design Envelope, but which are proposed for deployment at Morlais following consent, will require additional licencing from the Welsh Government and NRW.

3.8.2. Zoning

49. The MDZ has been provisionally divided into eight indicative subzones. Each subzone should have the potential to be developed with up to 30 MW of installed capacity in terms of resource availability and physical space for deployment. However, the eventual installed capacity of each subzone will vary based on the nature of environmental constraints, potential requirements for phasing of deployment and the needs of specific tidal device developers. The Project Design Envelope is designed to represent a realistic worst-case scenario, incorporating the technologies most likely to be deployed, at a capacity and in a location that is realistic.

50. Indicative layouts, each with a different combination of device arrays (sub-categories) in different locations were examined, based on a number of constraints, such as tidal resource, water depth navigation and potential seascape impacts. Further information on the devices included in the PDE and indicative layouts are presented in **Chapter 4, Project Description**.

3.9. IDENTIFICATION OF EXPORT CABLE CORRIDOR AND LANDFALL AREA

3.9.1. Route Feasibility and Screening

51. An area of coast from Holyhead to Trearddur Bay was analysed to identify suitable cable landfall points export cable corridors. Areas outside of this region were not considered due to the length of the subsea cables that would be required from the offshore development site.

52. Offshore constraints identified in the export cable route feasibility exercise were as follows:

- Distance from the development site offshore to the identified landfall points;
- Bathymetry;
- Ground conditions and water depth in the area at landfall;
- Shipping and navigation routes;
- Existing infrastructure;
- Military Practice and Exercise Areas (PEXAs);
- Aggregate dredging grounds;
- Nature conservation designations;
- Commercial fishing; and
- Sensitive seabed features.

53. The majority of the coastline in this area is covered by high level designations, including:

- Glannau Ynys Gybi / Holy Island Coast Special Protection Area (SPA), Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI);
- North Anglesey Marine / Gogledd Môn Forol SAC;
- Anglesey Terns / Morwenoliaid Ynys Môn SPA;
- Ynys Mon / Anglesey Area of Outstanding Natural Beauty (AONB);
- South Stack Cliffs Royal Society for the Protection of Birds (RSPB) Reserve; and
- Holyhead Mountain Heritage Coast.

54. In parallel with the landfall and export cable corridor assessment, Menter Môn identified location options for provisional landfall substations (described further in **Section 3.10**). **Figure 3-2 (Volume II)** illustrates the nearby nature conservation designations and initial long list of landfall and landfall substation locations.

55. Due to the heterogenous and complex nature of the coastal area evidenced by the large number of designations, a comprehensive site selection and feasibility assessment was undertaken to better understand the ecological and geological risks associated with each landfall and offshore export cable corridor option. Where possible, sensitive designation have been avoided. From this, offshore export cable corridors were outlined (see **Figure 3-1, Volume II**).

3.9.2. Export Cable Specifications

56. Three main options (and variations on these) for connecting the MDZ to the landfall location were reviewed as part of the route feasibility process;

- **Option 1:** Individual cable to shore for each subzone
  - Option 1a: Multiple cables for each subzone
  - Option 1b: Multi-core cable used so sub-zones are combined in pairs, with one 6 core cable per 2 sub-zones

- **Option 2:** Single 132kV cable to shore for all subzones with offshore substation
  - Option 2a: As Option 2 but with multiple sub-surface hubs
- **Option 3:** Radial arrangement with sub-zones strung along main cable
  - Option 3a: Passive offshore hub
  - Option 3b: Multiple 33kV cables to shore.

57. A detailed assessment of each of these options was undertaken within the Morlais Preliminary Design Options Report (ITPE, 2018). Option 1 was the overall preferred option for a project of this scale. It offers the most flexibility to the Morlais developers and would fulfil many of the points raised throughout the developer consultation exercise. It represents the least technical risk out of all the options as no unproven technology will be deployed. Furthermore, most of the active electrical systems will be located onshore thus further reducing the risk, operation and maintenance (O&M) costs and minimising reliability issues.

58. Option 2 and Option 3 were not deemed to be suitable as a feasibility basis for this project.

3.9.3. Export Cable Corridor Route Options

59. In parallel with the ECC route selection, three landfall options were identified from the search areas, Abraham's Bosom, Porth Dafarch and Holyhead (Soldier's Point), based on a review of offshore constraints.

60. Following this assessment, high-level routes were identified based on the following parameters (**Figure 3-1, Volume II**);

- Nine separate cable tails installed through the landfall by HDD;
- Eight subsea export cables connecting the Morlais tails to developer projects deployed within each sub-zone; installed independently;
- Separation of 10 m between HDD entry points;
- Separation of 20 m between HDD exit points;
- Cable tail length would be equal to the water depth multiplied by three, plus an additional 5 m buffer;
- Avoiding the worst of the seabed features, and slopes of more than 10 degrees; and
- At least 10 m separation between cables where possible.

61. The Morlais Substation Location Feasibility Study (ITP, 2016) provides an initial assessment of the potential offshore cable route, taking into consideration ground conditions and seabed hazards. Due to the hard and rocky nature of the seabed at the Project site, cable burial is not viable along the offshore sections of the export cable routes.

62. Gradients and complex bathymetry are likely to mean that even surface laid cables will be at risk of moving or sliding if laid across these gradient slopes. Cables in this position could slide and become snagged on rocks, potentially leading to cable damage and failure through abrasion and wear. This is particularly relevant for the cables in the Morlais project as they are being

installed in a high current environment. In addition, the complex bathymetry could result in suspensions due to the inability of the cable to conform to bottom irregularities. Large suspensions could also lead to potential cable damage through strumming, abrasion and wear.

63. Selection of cable protection will be based on the site-specific hazards expected in the MDZ (i.e. fishing). This is especially important as the admiralty charts show an anchorage area close to the landfall locations. Where possible, steep gradients will be avoided, and cables laid in line with the tide to minimise cross current effects. This will in part be mitigated against by careful positioning and routing of the cables.

3.9.4. Refinement of Export Cable Corridor

64. In parallel with the ECC refinement, Menter Môn were undertaking a detailed feasibility of the landfall point and landfall substation location, described further in **Section 3.10**. This resulted in three preferred landfall options at Abrahams Bosom; known as Option 1, Option 5a, Option 8 (and Option 8a). The refined area of the export cable corridor is shown in **Figure 3-3 (Volume II).** Porth Dafarch and Holyhead (Soldier's Point) were both discounted due to reasons associated with the landfall point and onshore cable corridor, in conjunction with the long export cable corridor routes from the MDZ compared to the Abrahams Bosom option**.**

65. Soldier's Point (search areas V, W, X, Y on **Figure 3-2, Volume II**) was discounted due to the proximity to the Breakwater Country Park and the high visibility from most locations within the Park. The area was also discounted, as indicated in **Plate 3-2**, due to the disruption to the main town of Holyhead associated with the installation of the onshore cable route selection within the road network.

Plate 3-2 Onshore cable route options to Grid Connection

66. The Porth Dafarch search areas (N, R, Q, S, U on **Figure 3-2**, **Volume II**) included Porth Dafarch beach, which is owned by the National Trust. This sheltered sandy beach is very popular, especially divers as there is a wreck of a cargo ship lost in 1886 (SS Missouri) a short distance from shore. The beach also has a subsea communications cable buried within it and there would not be sufficient space to avoid this cable. A number of constraints were present, such as;

- Narrow inlets in the area give little room for cable landfall;
- Areas of steep and high ridges to the south west of the South Stack Cliffs Nature Reserve requiring the cable to route around and therefore require a longer offshore cable route than most other options;
- The area is fairly visible with little natural screening available in some cases;
- Rock cutting or blasting required to bury cables where minimal sediment cover on beaches.

67. The Cable Routing Report (ITPE, 2018) provides a detailed review of both the offshore and onshore cable routes for the Morlais project. The Project will install up to nine export cables connecting the Landfall Substation to the offshore arrays. An overview of each route is provided in **Section 3.9.4.1** to **3.9.4.3** below.

3.9.4.1. Routes from Landfall Option 1

68. The total length of the nine zone export cables (to the easternmost boundary of each subzone only) is approximately 31 km with this option.

69. Up to 120 individual rock bags or concrete mattresses is estimated to be required for this option.

70. This route uses the most northerly landfall of the three options. It presents slightly more cable installation challenge as the Horizontal Directional Drill (HDD) exit points are furthest into the bay and the sub-zone export cables require routing round the complex bathymetry to the north of the bay.

3.9.4.2. Route from Landfall Option 5

71. The total length of the nine export cables (to the easternmost boundary of each subzone only) is approximately 30.5 km with this option.

72. Up to 120 individual rock bags or concrete mattresses is estimated to be required for this option.

73. This route uses the central landfall of the three options. It has the shortest total HDD drill length and although the drill exit points are far into the bay, they are in the middle, emerging into a relatively flat area, allowing good routing options towards the MDZ.

3.9.4.3. Route from Landfall Option 8

74. The total length of the nine export cables (to the easternmost boundary of each subzone only) is approximately 27.5 km with this option.

75. Up to 120 individual rock bags or concrete mattresses is estimated to be required for this option.

76. This route uses the most southerly landfall of the three options. The HDD exit points are furthest out into the bay at presents a good line for the most northerly routes/cables.

3.9.4.4. Selected Offshore Cable Route

77. This study was undertaken in parallel with the identification of landfall substation location, which is described fully in **Section 3.10** and should be read in conjunction with this Section (**Section 3.9**). From this assessment, Option 1 is the preferred landfall option based upon proximity to the preferred landfall substation location. The ECC presented in **Figure 3-3** (**Volume II**) illustrates the area within which each export cable will be positioned from each array, along the coastline where necessary and into Abrahams Bosom.

78. The final export cable route will be undertaken at the detailed design stage, utilising fine scale geophysical data. These may be installed either as a continuous export cable from onshore substation, each cable installed by a tenant to the Project or as a cable tail installed from the onshore substation to a location several hundred metres and each up to 620 m long. Each 'tail' would be terminated in the near shore of the export cable corridor, shortly after the 'break out' of planned HDD or trenching.

3.10. IDENTIFICATION OF LANDFALL AND LANDFALL SUBSTATION LOCATION

3.10.1. Site Feasibility and Screening

79. The cable landfall point for a tidal project is a critical part of the whole project; not only does it determine the length of the export cables in the subsea environment, but to a large extent, the approximate location of the landfall substation. This is because the landfall substation should be

as close as possible to the landfall point to reduce the distance the nine export cables would be laid onshore. This study was undertaken in parallel with the identification of the ECC, which is described fully in **Section 3.9** and should be read in conjunction with this Section (**Section 3.10**).

80. The initial desk-based search focussed largely on landfall sites, with associated substation locations identified nearby. A site visit to each of those locations was then undertaken. Important factors that were considered in the initial selection / screening of the cable landfall and substation sites are shown in **Table 3-3**.

Table 3-3 Key Considerations for Screening of Cable Landfall and Substation Site Selection

Factors	Criteria	Comments for Screening of Sites
Inter-project aspects	▪ Minimise the distance from landfall to the substation location ▪ Availability of space to locate an onshore substation, laydown and construction areas ▪ Consideration of likely grid connection points ▪ Ease of access to the substation and landfall site particularly for construction and delivery vehicles ▪ Subsea cable route length and challenges	▪ Preference for substation to be less than 1 km from landfall, to minimise extent of disruption ▪ Ease of access to the substation and landfall site for construction and delivery vehicles important, particularly to minimise disruption on Holy Island's minor roads ▪ Factors affecting the subsea cable route considered include; distance from the MDZ site; sea bed topography; water depth and ground conditions in the area immediately offshore from landfall
Physical baseline	▪ Avoid very high cliffs, hard rock strata and uneven and rocky ground ▪ Flood risk constraints	▪ The coastline in the search area has very few areas that are not high or has steep cliffs and the bedrock is extremely hard. ▪ Hard constraints for the search were taken as cliffs with a height above 50 m and extremely rocky or steep ground, thus the majority of the South Stack Cliffs Nature Reserve was excluded.
Environmental baseline	▪ Onshore nature conservation designations are generally avoided where possible ▪ Marine sensitivities to be considered for offshore cable route required to make landfall option ▪ Natural screening potential	▪ The search area has a large number of designated areas including Special Protection areas (SPAs), Special Areas of Conservation (SACs), AONBs, and Sites of Special Scientific Interest (SSSI) designations, as well as local nature reserves and a Country Park ▪ Marine sensitive areas that the route will cross such as environmental designations and fishing grounds minimised ▪ Designations could be avoided except where there existed a particularly attractive landfall or substation site

Factors	Criteria	Comments for Screening of Sites
Socio-economic baseline	▪ Proximity of residences ▪ Cultural heritage designations	▪ The majority of the Holy Island headland is covered by the Holyhead Mountain Heritage Coast

81. The desk-based search for suitable cable landfall and onshore landfall substation locations used Ordnance Survey maps, as well as aerial photography from Google Earth and Bing Maps. GIS data on environmental and cultural designations, sensitive habitats, landscape quality, coastal features, elevation, geology, bathymetry and seabed characteristics, flood risk and other constraints (such as proximity to residences) were also mapped for the search area. Additionally, considerations such as access and technical feasibility of likely construction methods were also applied to each potential location.

82. The search identified 15 possible landfall locations, with 13 associated possibilities for landfall substation locations identified. Two locations allowed the possibility of co-locating the landfall and substation (search area ‘B’ and ‘N’). All potential locations and routes were visited by the project engineering team. Landfall sites were also viewed from the sea during a vessel-based search. Each potential area is illustrated in **Figure 3-2 (Volume II)**.

3.10.2. Landfall Construction Options

83. The nature of the coastline at the landfall site is a key consideration in determining how landfall is achieved. An ‘open cut trench’ is the standard method of achieving landfall for offshore energy projects; however, this requires a generally flat coast and route to the onshore substation / control room location.

84. HDD is the preferred construction method proposed for the landfall, given the presence of cliffs, reefs, dunes and other sensitive habitats as well as hard rocky strata. However, the use of ducts or J-tubes pinned to the cliff and laid in a trench / slot are also assessed within the EIA, as a back-up should HDD be found to be technically infeasible at a later stage.

3.10.3. Site Short-Listing

85. Between June and October 2016, ITPE carried out a feasibility study to identify possible landfall and substation locations for the Project. The site visits and walkovers entailed an assessment of space, land cover, visibility, possible ground conditions, land stability issues and constraints to development, as well as confirming features, elevations and measurements on maps. Proposed cable routes and possible access routes were driven and areas of difficulty such as tight corners and narrow sections assessed. During the site visits, soil probing was also undertaken across the search areas visited to give an indication of the depth of soil for cable trenching, in conjunction with the use of soil cover maps from the NERC (Natural Environment Research Council).

86. Using exiting information and new knowledge gained from the site visits, the GIS system and a comparative costing exercise, as well as further assessment against all of the technical requirements and constraints, the list of sites was refined. A comparison between the potential onshore infrastructure locations was undertaken taking into account the following:

- Nature Conservation Designations;
- Sensitive habitats and environments;
- Considerations for substation location (e.g. space, proximity to residences, amenity and sensitivity of surrounding area);
- Ease of (and options for) landfall;
- Able route between landfall and substation;
- Ground conditions;
- Route to grid connection;
- Subsea cable route (length as well as possible installation concerns);
- O&M considerations; and
- Costs.

87. At the time, the outline design and construction method statement for all options was based on the following assumptions:

- 12 cable runs offshore – 12 cables will be laid individually, cables would be bundled for installation. Eight cables will require fewer runs;
- 12 HDD routes are required – for 24 cables, two cables will be pulled through each duct. Eight cables will require fewer drills;
- A transition pit is required for all cases where HDD is undertaken to joint subsea cables to land cables. A maximum of three cables are jointed in any one pit;
- Cables are laid approximately 800 mm apart in the onshore trench, requiring a 20 m wide trench for 24 cables; and
- Offshore cable tails are installed upon the seabed, to a distance of several kilometres offshore.

88. A full assessment of the landfall and substation search areas shown on **Figure 3-2** (**Volume II**) was conducted. A summary of the key constraints and outcomes is provided in **Table 3-4**.

Table 3-4 Long List of Landfall and Substation Search Areas

Search Area	Project Area	Description	Assessment
A	Substation	Consists of 11 fields and some small pockets of heathland	▪ The area closest to South Stack Road is sloping and highly visible from many viewpoints. To the north of those five fields there is an area adjoining Welsh Water reservoirs. This location is up to 1 km from the landfall point.
B	Substation	Consists of five sloping fields at cliff top overlooking Abrahams Bosom	▪ The site is in an exposed location is situated on high cliffs which adjoin the South Stack Cliffs RSPB Reserve, and the Holy Island Coast SSSI, SAC and SPA.

Search Area	Project Area	Description	Assessment
			▪ The cliffs to the south of the area appear to be variable in nature, with some areas of visible landslip, making this more less technically feasible for HDD works.
C	Landfall	Consists of two fields, between South Stack Road and the coast	▪ There are higher cliffs than most of the preferred landfall locations which also appear to be variable in nature, with some areas of visible landslip, potentially making this more challenging for drilling. ▪ Drill setback required for cliff height likely to make this option less technically feasible. ▪ The site is close to residences.
D	Landfall	Consisting of a single large field	▪ The is situated slightly further from the coast than other search area option and offers better prospects for achieving landfall.
E	Landfall	Consists of six fields and high cliffs	▪ Drill setback required for cliff height would severely restrict the space available to undertake the number of drills required, making the works less technically feasible.
F	Landfall	Single field separated from the cliff by the coastal road	▪ Search area is situated within the South Stack RSPB Reserve. ▪ The rocky seabed in the immediate vicinity is likely to require a slightly longer drill than other areas
G	Landfall	Two large fields	▪ Search area is situated within the South Stack RSPB Reserve. ▪ The cliff is higher in the area than the surrounding areas, this area will require a longer set-back distance than others, placing restrictions on the potential drill locations. ▪ A longer drill would be required (to the west) due to protruding rocks in the sea at the foot of the cliff.
H	Substation	Consists of a total of 12 fields surrounding farm building	▪ Two of these three areas may potentially have issues with water levels as they adjoin wetlands ▪ The area to the north of the main residence is quite visible from many viewpoints in the surrounding area. ▪ The location closest to the house has mounds of earth / rock on two sides, allowing for some natural screening for the substation. ▪ The location does not lie adjacent to the landfall point
I	Landfall	Consists of four adjoining fields	▪ Search area is situated within the South Stack RSPB Reserve. ▪ Adjoins a potential substation area, offering a very short onshore trench and the possibility of avoiding

Search Area	Project Area	Description	Assessment
			the need for transition pits by taking the subsea cables directly to the substation. ▪ The fields next to this potential landfall point are steeply sloped and quite visible from other viewpoints. Drills may have to be directed in a more westerly direction than straight out to sea to achieve sufficient setback. ▪ This landfall option offers one of the shortest possible subsea cable routes, broadly similar to the Abraham's Bosom option.
J	Substation	Consists of two fields adjacent to residential property	▪ This area is also close to a caravan park as well as adjoining the South Stack Cliffs RSPB Reserve and Holy Island Coast SSSI, SAC and SPA ▪ There is limited space for a substation and is highly visible from the surrounding area. ▪ The nearest landfall point is very close, approximately 400 m.
K	Substation	Consists of seven fields	▪ There are multiple options within this location that could be suitable and is quite well obscured. ▪ There are three landfall possibilities for this location.
L	Substation	Consists of a single field	▪ Site is within close proximity to Standing Stones heritage asset. ▪ The site is raised and on a slight gradient which makes it quite visible to the surrounding area. ▪ The nearest landfall points are at a distance of approximately 900 m to 1200 m.
M	Substation	Consists of two fields	▪ The site is higher in altitude than surrounding land and therefore quite visible. ▪ Site is also further from the coast than nearby alternatives.
N	Landfall and Substation	Consists of three fields and a narrow inlet	▪ The cliffs in this immediate area are low and this location is relatively obscured, however the Isle of Anglesey Coastal Path passes through the area. ▪ This inlet is within the Holy Island Coast SSSI, SAC and SPA designations and the steep bank to the north would need to be excavated for the trench. ▪ If HDD works were undertaken, the rock appears to have weak layers crossing the drill path causing eroded areas visible along the side of the inlets. ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.

Search Area	Project Area	Description	Assessment
O	Substation	Consists of four fields	▪ The fields in this area are fairly visible from the surrounding area. ▪ Situated to the north west of Porth Dafarch Beach adjoining the coastal road.
P	Substation	Consists of four fields	▪ The eastern most corner of this area offers a well obscured location ▪ Lies approximately 700 m to 800 m to the north east of Porth Dafarch Beach. ▪ The site is a long distance from the nearest landfall locations which are both challenging and would require a long onshore trench.
Q	Landfall	Area includes Porth Dafarch beach; owned by The National Trust.	▪ This sheltered sandy beach is very popular, especially divers as there is a wreck of a cargo ship lost in 1886 (SS Missouri) a short distance from shore. ▪ The beach also has a subsea communications cable buried within it. ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.
R	Landfall	Consists of a single field	▪ A long drill will be required in order to achieve landfall as the ground conditions are difficult due to little flat / even grounds. ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.
S	Landfall	Area of field and including the Porth y Corwgl beach	▪ Gentle gradient from the beach, however there is minimal sediment cover. ▪ This area offers the prospect of landing the subsea cables with no drilling ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.
T	Substation	Several fields to the north east of Porth y Corwgl	▪ The Western site boundary is adjoining the Holyhead Golf Club ▪ The furthest north east corner as this portion of the site is well obscured, however there are a number of residences within close proximity to the site.

Search Area	Project Area	Description	Assessment
			▪ The nearest landfall is approximately 550 m to 1000 m
U	Landfall	Area of land between two beaches	▪ This area offers the prospect of landing the subsea cables with no drilling ▪ As there is minimal sediment cover on either of these beaches; rock cutting or blasting will be required to bury cables if surface laying would not be acceptable at his location. ▪ This area is within close proximity to many residences; it would be difficult to route a wide enough cable trench through houses, and/or along the narrow road to the nearest substation location. ▪ Porth y Post beach has a subsea communications cable installed within it; although it is unclear whether this is still in use. ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.
V	Landfall	Consists of three fields and cliff top land	▪ A wastewater treatment works outfall pipe (WwTW) was previously installed in this area. As work was previously undertaken at this site, the ground conditions are known. ▪ This site is located within the Breakwater Country Park and is highly visible from most locations within the Country Park. ▪ The cliffs along this area is relatively low which means there could be many drill locations at this wide area. ▪ Due to distance from the MDZ, this option will require longer subsea cable route.
W	Landfall	The pebble beach immediately to the west of the Holyhead breakwater	▪ The wide beach offers approximately 100 m of ‘useable’ width to achieve landfall through open cut trenching. ▪ The beach consists of large cobbles and boulders (upwards of 200 mm in diameter) with a few isolated areas of exposed bedrock. ▪ Due to distance from the MDZ, this option will require significantly longer subsea cable route.
X	Substation	Area is located to the south of Holyhead breakwater	▪ Area adjoins a Stena Line storage shed. There would be no need for change of land use from current industrial use.

Search Area	Project Area	Description	Assessment
			▪ Short distance from landfall point, approximately 200 m.
Y	Substation	Land located to the south of the Breakwater Country Park	▪ This site sits outside the park boundary as well as other designations, however as the area is slightly raised, it is visible from the country park. There is a limited amount of flat space in this search area. The distance to the closest possible landfall point is between 400 and 500 m.
Z	Landfall	Consists of one field and a narrow inlet with a beach	▪ Consists of a beach with approximately 18 m of 'useable' width ▪ This site is within the South Stacks Cliffs nature reserve and was possibly the former site of a lifeboat station. Landfall at this location could possibly be achieved with open cut trenching, ▪ This inlet is within the Holy Island Coast SSSI, SAC and SPA designations and the steep bank to the north would need to be excavated for the trench. ▪ The subsea cable route from the offshore site would have to either cross through or be routed around the area of steep and high ridges to the south west, thus a longer subsea cable route is required for this location.

89. This assessment resulted in 14 different potential options of landfall and substation combinations, comprising seven different landfall sites and nine different substation locations, as summarised in **Table 3-5**.

90. From this, nine options were selected; Option 1; Option 2; Option 5; Option 6; Option 7; Option 8; Option 8a; Option 9; and Option 13. With the exception of Option 13, which is located in Holyhead, all sites are located in areas close to Abraham's Bosom.

91. The outline designs for each of the short-listed options are shown in the Project Design Envelope Definition (ITPE, 2018). Possible outline layouts for each option are available for both a trenched landfall and HDD approach.

Table 3-5 Comparison of Potential Onshore Infrastructure Location Options

Option No. (landfall & substation)	Distance from Nature Conservation Designation (m)[1]					Distance from Heritage Coast Designation (m)	Landfall construction method	Closest residential property (m)[2]	Cable route to substation (km)	Grid connection route (km)	Subsea cable route (km)[3]
	SSSI	SPA	SAC	AONB	RSPB						
Option 1 (D & A)	<10	<10	<10	0	<10	<10	HDD	<100	0.7	8.3	44
Option 2 (F & A)	<10	<10	<10	0	0	<10	HDD	250	1.1	8.3	44
Option 3 (F & H2)	50	50	50	0	0	<10	HDD	250	0.4	7.0	44
Option 4 (G & H2)	<10	<10	<10	0	<10	<10	HDD	250	0.5	7.0	43
Option 5 (G & H1)	<10	<10	<10	0	<10	<10	HDD	150	0.4	6.7	43
Option 6 (I2 & H1)	<10	<10	<10	0	<10	<10	HDD	150	0.2	6.7	43
Option 7 (I1 & H1)	<10	<10	<10	0	<10	<10	HDD	150	0.6	6.7	43
Option 8 (I1 & K)	<10	<10	<10	0	0	<10	HDD	<100	0.5	6.0	43
Option 8a (I1 & J)	<10	<10	<10	0	<10	<10	HDD	<100	0.3	6.5	43
Option 9 (I2 & K)	<10	<10	<10	0	0	<10	HDD	<100	0.5	6.0	43
Option 10 (N &N)	<10	<10	<10	0	300	<10	Trench	250	<0.1	6.0	85
Option 11 (N & P)	<10	<10	<10	0	300	<10	Trench	150	1.4	3.5	85
Option 12 (N & T)	<10	<10	<10	0	300	<10	HDD	150	1.7	3.5	85
Option 13 (X & W)	<10	<10	<10	700	900	900	Trench	<100	<0.1	5.0	81

[1] Closest distance of either substation or landfall location to nature conservation designation
[2] Closest distance of either substation or landfall location to residential properties
[3] Assuming 12 cables

92. In association with this study, proposed onshore cable routes and possible access routes were also taken in to consideration and areas of difficulty such as tight corners and narrow sections assessed. The selection of the onshore cable route is described in more detail in **Section 3.12** but should be read in conjunction with this Section (**Section 3.10**).

93. Through elimination of the less feasible options, the preferred landfall location was narrowed down to four possibilities, with some variation possible if necessary**.** These are outlined below and shown on **Figure 3-4 (Volume II)**:

- Option 1;
- Option 5a;
- Option 8a; and
- Option 8.

3.10.3.1. Option 1

94. The proposed Option 1 landfall substation was initially positioned in the furthest northern point of the search area identified **(Figure 3-4, Volume II)**. The substation location was considered to be well obscured next to an existing water works. However, the cable routes to grid connection as well as between landfall and substation were considered to be long and therefore other substation locations closer to the landfall were explored for this option.

3.10.3.2. Option 5a

95. The proposed Option 5a landfall and landfall substation is located far from roads and most designations and is a well obscured location. However, there are access issues and challenging ground conditions with possible flood issues. The space is also very small. The landfall is outside of the RSPB reserve, but very close to the boundary. The steep cliffs and then gradually sloping seabed also make HDD more challenging. Multiple landowners are present and initial discussions identified that some were not supportive. Therefore Option 5 was not taken forward for development.

3.10.3.3. Option 8 and 8a

96. The proposed landfall for Option 8 has a very short cable route to the proposed landfall substation location, which is the most accessible and one of the best prospects for connection to the onshore cable corridor. However, the substation was considered to be very visible and in close proximity to residences. Therefore Option 8 and 8a were not taken forward for development.

3.10.4. Refinement of Landfall and Substation Locations

97. As outlined above, Option 1 for the landfall location was the option selected on the basis of landowner support, minimising visual impact and technical feasibility.

98. Further refinement of the landfall substation location has been undertaken since the FEED study undertaken by ITPE. Black and Veatch Ltd. (B&V) have been responsible for the further design

of the onshore infrastructure within the ODA, including the landfall substation. Micro-siting of the landfall substation within the search area shown on **Figure 3-4 (Volume II)**, was undertaken in parallel with the completion of the EIA. Due to the position of the substation within the AONB, the potential visual impact was an important consideration. In collaboration with visual impact specialists from IoACC and NRW, a final site was chosen, within a recessive location in the landscape and uses the landform to help integrate the substation into the landscape.

99. Owning to the landfall substation location within the vicinity of the Ty Mawr farm, landowner consultation was undertaken frequently during the selection process.

3.11. IDENTIFICATION OF THE GRID CONNECTION POINT

100. It was assumed that a grid connection at 132 kV would be required. Four possible grid connection points were assessed by ITPE;

- 'Orthios' 132 kV connection point;
- 'Parc Cybi' 33 kV connection point;
- 'Valley' 132 kV connection point; and,
- Caergeiliog 132 kV connection point.

101. The 132 kV grid connection point 'Orthios' is the closest suitable 132 kV connection point and there are multiple options for cable routing in minor roads or cross country to minimise disruption during construction. The location is a brownfield site and already developed therefore there would be no significant change to the nature of the surroundings with further development.

102. Although the infrastructure of the 33 kV connection point at 'Parc Cybi' is not sufficient to accommodate the full project capacity, this would offer connection to the local electricity network. The location of Parc Cybi offers cable routing along mainly minor roads from all but the Holyhead landfall search area, as well as some potential cross-country routes.

103. The 132 kV connection point 'Valley' may be a suitable alternative to Orthios, however there is potential for disruption to major roads if the cable is not to be routed cross country. Valley is also a greenfield site rather the brownfield site (such as the Orthios site). There is possibly slightly better connection point about 700 m to the west, which is the same line into which connection at Anglesey Aluminium would be achieved, albeit some distance further south, and necessitating crossing of the estuary. Owing to the above reasons and the distance from the landfall location, it was considered to be significantly less attractive than the 'Orthios' point.

104. The 132 kV connection point 'Caergeiliog' is located further south east from Valley. This connection point also offers good connection potential within the existing grid substation site. There would likely be less road disruption than with the nearby 'Valley' connection point, although the minor road offering the best option for a cable route is very narrow and appears to support several utilities already. Due to the distance from the landfall location, it was also considered to be significantly less attractive than the 'Orthios' point.

3.11.1.1. Selected Grid Connection Point

105. The 132 kV grid connection point 'Orthios' is the most attractive prospect for grid connection for the full scale 240 MW project, being the closest suitable 132 kV connection point to the selected landfall location. There is sufficient space available at the connection point to enable construction of a separate substation and there are multiple prospects for cable routing in minor roads or cross country offering little disturbance to adjacent habitats during construction. minimising of visual impacts was considered in detail during the selection of these sites.

106. In addition, the 33 kV connection point at 'Parc Cybi' is selected as a suitable location for a switchgear building. This would offer connection of early phases of the Project to the local electricity network, whilst the 132 kV grid connection point 'Orthios' is connected to the national transmission network. The two connections provide flexibility in supporting the connection of the Project to the existing electricity supply and in the way in which the Project can best suit the demand for capacity and consumers.

107. In parallel with the completion of the EIA, outline design of a grid connection substation at the 132 kV grid connection point 'Orthios' (hereafter referred to as Grid Connection Substation) and a switchgear building at the 33 kV connection point at 'Parc Cybi' (hereafter referred to as Switchgear Building) has been completed. B&V have been responsible for the further design of the onshore infrastructure within the ODA, including the Landfall Substation.

3.12. IDENTIFICATION OF THE ONSHORE CABLE ROUTE

108. Given the rural nature of the project, the location of the AONB, public perception and consultation with IoACC, it was decided that overhead cables would not be appropriate. The cables will be trenched into the local road network, so much as is practicable to avoid impacts to adjacent habitats during construction and will minimise disruption to local landowners.

109. The route options were broken down into segments because there are multiple options for certain sections of the route, therefore many permutations of options are possible to form the overall route. An overview of the segments of the route is illustrated in **Figure 3-5** (**Volume II**).

110. The segment approach simplifies the overall assessment by allowing each segment to be assessed and added separately. The onshore cable route feasibility was undertaken in parallel with the landfall site selection and therefore these shortlisted route options were selected based on the anticipated likely landfall locations, Option 1, Option 5a and Option 8 and 8a. The assessment was refined during the full site selection process and the final route selection is based on the selection of Option 1 as the preferred landfall option.

111. The Segment 1 options provide a route from the expected landfall area substation to the Switchgear Building shown on **Figure 3-5** (**Volume II**). The Segment 2 options connect Segment 1 to the Grid Connection Substation **Figure 3-5** (**Volume II**).

112. Segment 3 covers the possible cable route options from the 132kV Orthios substation to the 132kV overhead lines at Valley. Due to the grid connection point at Valley being discounted early in the site selection process (as described in **Section 3.11**), Segment 3 is not considered further in this section, although initial feasibility options for access were assessed (**Table 3-6**).

Table 3-6 Onshore cable route Segment 3 options

Option	Description
A5 Stanley Embankment	▪ From the Orthios site, this route follows east and picks up the A5 across the Cymyran Strait, utilising either the road itself, the pedestrian pathway alongside it, or the existing services trench adjacent to the pedestrian path. ▪ The route turns north to the Valley connection site either in the first field east of Stanley Embankment, at Gorad Road, or at the A5025 road.
A55 Expressway Bridge	▪ From opposite the Orthios site, south side of the railway, this route follows east through the A55 across the Cymyran Strait. ▪ On the east side of the straight the route follows north through fields to pick up the eastern end of the A5 Stanley Embankment option.
HDD under the Cymyran Strait	▪ An alternative option for Segment 3 would be to HDD under the Cymyran Strait. ▪ The crossing would be over 1,500 m in length. ▪ An HDD of this length is beyond the normal range of HDD and this could also introduce issues with excessive pulling forces exerted on the cables. ▪ Entry and exit compounds would be required on either side of the strait and no area is apparent on the west side other than Orthios itself. Due to the unlikely feasibility and appetite for this option.

113. For Segment 1, the preferred option is the Porthdafarch Road and Holyhead Leisure Centre. This route option appears to be feasible and has clear advantage over the alternatives which would pass through or near to residential areas and narrow roads within Holyhead town.

114. For Segment 2 the preferred route is along the A5153 and the A5 London Road, or to access the Grid Connection Substation from a location near the Switchgear Building and to the south of the A55 using HDD.

115. A qualitative assessment of the route options for a given cable route segment has been undertaken to understand the issues and challenges for cable installation. The route was divided into three segments representing possible connection to three different connection points: Parc Cybi, Orthios and Valley. The following criteria were considered for each option;

- **Space** – refers to the general space or corridor width available for cable construction works along the route. It also includes localised width restrictions such as bridge crossings, or areas where land use, geology, infrastructure, or environmentally sensitive areas restrict the width for construction. This also considers related health and safety risks such as working in narrow roads with heavy traffic or working near livestock or overhead electricity lines. The availability of any verge adjacent to the road has been included for consideration, where possible, and whether any close settlements or structures are built up alongside the road, which would prevent use of the verge for construction or the cable trench.
- **Obstacles** - localised constraints which the cable route would need to cross via open cut trenching, or in some instances more specialised methods, such as cable bridges, auger boring or by HDD. Obstacles could be, for example, railways, major roads (such

as A or B roads), bridges, watercourses, and small woodlands or rough terrain, or services. A view has been provided on health and safety risks such as where the cable route crosses electricity lines or similar.

- **Services** – whether additional crossings are required to avoid assets such as underground electricity cables, gas pipelines, telecommunication lines, and water or sewage mains. The presence of other services affects useable installation space, disruption of works, technical feasibility and impacts on health and safety.
- **Access** - ease of access for construction, such as distances for parts of the cable route from major transportation arteries such as A or B roads, freight lines, or ports, or through roads with significant weight, width or height restrictions. Health and safety risks have been considered such as if dangerous vehicle movements are required for construction.
- **Environmental constraints** – consideration of ecological and land use constraints, including nature conservation designations, minimising disturbance to adjacent habitats, species, landowners, avoidance of archaeological and heritage assets.

3.12.1. Route Segment 1

116. **Table 3-7** contains the options for Segment 1 of the onshore cable route. These options follow public highway from the landfall to the Parc Cybi area

Table 3-7 Onshore cable route Segment 1 options

Option	Description	Assessment
South Stack Road	▪ From the landfall substation area, this route follows South Stack Road to the northeast to Holyhead. ▪ From there the route follows roads in town to connect to Kingsland Road. ▪ The route follows Kingsland Road to the A5153 and Parc Cybi road. ▪ The route crosses to the north of the A55 at a point near the Parc Cybi 33kV substation. ▪ The route follows along the north side of the A55 to Orthios substation.	▪ This is a two-lane road and appears to have space for a cable trench. ▪ There are hedgerows close to the north side of the road and residences with pavement, a stone wall and lighting services along the south side of the road. ▪ Through parts of the town there is pavement and stone wall on both sides of the road. ▪ There appears to be services in the road (water and drainage) and services which cross the road overhead. ▪ To the North approaching Holyhead, installation through this area is likely to be very disruptive for residents. There is likely to be several services in the road which presents a risk that there will not be enough space for the cables. ▪ From here the route follows the A55 then Kingsland Road which are two-lane roads. Several roundabouts would need to be negotiated. Kingsland Road passes through a built-up residential area with pavements either side.

Option	Description	Assessment
Plas Road	▪ From the landfall substation area, this route follows the road along the coast to Penrhosfeilw, then Plas Road to the northeast to Holyhead. ▪ The route would need to go through some narrow roads near Holyhead to join Kingsland Road. ▪ The route follows Kingsland Road to the A5153 and Parc Cybi road. ▪ The route crosses to the north of the A55 at a point near the Parc Cybi 33kV substation. ▪ The route follows along the north side of the A55 to Orthios substation.	▪ This road along the southern coast is single lane and flanked by stone walls on either side. ▪ There are several 90-degree bends in the road. ▪ There are certain areas where the road passes residences and there are walls on either side of the road. ▪ Other large portions of the road have a stone wall and hedgerow along its east side and hedgerow/scrub plus overhead service on its west side. ▪ Installation through this area is likely to be very disruptive for residents, likely requiring partial closure for the working section. ▪ The north end of the road follows through Kingsland which is built up with residential housing, where it joins the 'South Stack Road' option which is described above.
Porthdafarch Road	▪ From the landfall substation area, this route follows the road along the coast to Porth Dafarch, then Porthdafarch Road to the northeast to Holyhead where it joins Kingsland Road. ▪ The route follows Kingsland Road to the A5153 and Parc Cybi road. ▪ The route crosses to the north of the A55 at a point near the Parc Cybi 33kV substation. ▪ The route follows along the north side of the A55 to Orthios substation.	▪ Overhead services cross the road at multiple locations. ▪ There is a rock formation very close to the east side of the road for about a 200 m stretch. ▪ There are hedgerows, scrub and stone walls along portions of the road. ▪ The road passes through Caer Bothan and Kingsland. Through this residential section there appears to be a water network in or near the road, the pavement switches to the east side of the road, and there is lighting services alongside the pavement. ▪ Residences are built close to the road. Installation through this area would seriously affect residential access. ▪ There are likely to be services in the road which means there is a risk that space will not be available for the cables.
Porthdafarch Road and Mill Road	▪ From the landfall substation area, this route follows the road along the coast to Porth Dafarch, then Porthdafarch Road to the northeast. ▪ The route turns eastward and follows Mill Road to Holyhead. ▪ The route picks up the A5153 and Parc Cybi road.	▪ Mill Road is a small side road providing access to at least one farm and several residences. ▪ The southwestern end has a wide bell mouth which would facilitate turning the cables through this road. This end is also relatively flat and varying in width between 4 m and 6 m, with several bends in the road but none too severe. ▪ At the northern section of the road, there are more residences, some very close and directly adjacent to the road, with hedgerows up

Option	Description	Assessment
	▪ The route crosses to the north of the A55 at a point near the Parc Cybi 33kV substation. ▪ The route follows along the north side of the A55 to Orthios substation.	against the other side, and some of these land plots are used for animal grazing. Installation would cause significant disruption to the residences close to the road. ▪ There appears to be evidence of a service trench through the middle of the road, and there is an overhead service adjacent to the west side of the road.
Porthdafarch Road and Holyhead Leisure Centre	▪ From the landfall substation area, this route follows the road along the coast to Porth Dafarch, then Porthdafarch Road to the northeast. ▪ The route turns eastward on Mill Road and follows it for 500 m. ▪ At this point the route diverts to the field and follows alongside or through the Holyhead Leisure Centre. ▪ The route picks up the A5153 and Parc Cybi road. ▪ The route crosses to the north of the A55 at a point near the Parc Cybi 33kV substation. ▪ The route follows along the north side of the A55 to Orthios substation.	▪ The route would cut across the field in a north-westerly direction, avoiding the sharp bend in the road. This field appears to be used as a pasture for livestock and there is a field gate access. ▪ The route would cross about 50 m of this field to reach the boundary of the Holyhead Leisure Centre site. ▪ The area to the southwest and west of the site appears to be disused scrubland. ▪ An alternative route would be through the leisure centre road and car park itself, there are the presence of water, drainage or sewage services which would need to be crossed.

3.12.2. Route Segment 2

117. **Table 3-9** contains the options for Segment 2 of the onshore cable route. These options connect the end of Segment 1 and the Parc Cybi area, where the Switchgear Building is to be location, to the eastern part of the Orthios site, where the Grid Connection Substation is to be located.

Table 3-8 Onshore cable route Segment 2 options

Option	Description	Assessment
A5153 and A5 London Road	▪ From near the Parc Cybi area, this route would follow the A5153 to cross the railway utilising the road bridge or the pavement on either side of the road bridge. ▪ The route follows the A5153 through several roundabouts to the A5. ▪ The route follows the A5 to the east side of the Orthios site.	▪ This bridge has a roundabout between the road and the railway bridge sections and is about 20 m wide overall, consisting of a 6-8 m wide lane in each direction and 1-2 m pedestrian pavements on both sides. There is likely to be some low voltage power supply cables in the pavement ▪ From north of the railway, the A5 is one wide lane in each direction and follows around the

Option	Description	Assessment
		north of the Orthios site, providing access for the industrial site and a few small residences. ▪ There is a national cycle path which follows on its eastbound (north) side of the road, separated by about a 1 m grassy verge.
Edge of Orthios Site	▪ From near the Parc Cybi substation, this route follows north and crosses the A55 and railway just to the southwest of the Orthios property. ▪ It follows the southern boundary of the Orthios site, adjacent to the north side of the railway, to the 132kV substation.	▪ There is a wooded area on the north side of the railway directly opposite this location. This route would cross the A55 and railway with HDD from a location east of the wooded area to the southwest corner of the Orthios site. Space seems to be available for HDD compounds on either side. ▪ Several private rail tracks running along the southern side of the Orthios site which are likely to be disused due to closure of the aluminium works. They would require removal to allow space for the cable trench.
A55 North Wales Expressway	▪ From the Parc Cybi substation, this route would either follow in the A55 or in the verge of the A55 to a position opposite the 132kV Orthios substation south of the railway. ▪ The route crosses the railway at this location to the Orthios substation.	▪ The A55 can be reached from Parc Cybi to its north. Through this area the A55 is a dual carriageway with a median of about 4.5 m wide. It may be possible to install the cables through the median, or in one of the lanes. This may require closure of one direction of traffic for access and safe working. ▪ To cross the railway to the Orthios site, the best place for HDD would be from the field just east of the 132kV Orthios substation to the large field on the south side of the A55. Both fields appear to offer sufficient space.

3.12.3. Refinement of Onshore Cable Route

118. Following the above assessment, on option has been progressed from each of the two segments. From Segment 1, the selected onshore cable route follows Porthdafarch Road and past Holyhead Leisure Centre to the Switchgear Building. This avoids the residential areas of Holyhead and minimises disruption to local residents.

119. From Segment 2, the preferred option is to use HDD to cross the A55, avoiding disturbance to the main route between Holy Island and the Isle of Anglesey. This decision was subject to extensive investigation with relevant stakeholders

120. The preferred options for each of the route segments are summarised in **Table 3-9**.

Table 3-9 Onshore Cable Route Preferred Options

Segment	Preferred Option	Notes
1	Porthdafarch Road and Holyhead Leisure Centre	This preferred option for Segment 1 follows public highway for most of the route whilst largely avoiding busy areas of Pont Hwfa, Holyhead and Kingsland. The diversion through the leisure centre would be a good alternative to the north portion of Mill Road, allowing for less disruption to local traffic within Holyhead and a more direct route to Parc Cybi. From Mill Road the route joins the A5153 and on to Parc Cybi road to meet the Parc Cybi site
2	A5153 and A5 London Road	The preferred option for Segment 2 follows the A5153 to cross the A55 and railway utilising trenchless crossing methods. The route follows the A5153 through several roundabouts to the A5, then follows the A5 to the east side of the Orthios campus.

3.13. REFERENCES

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