# HYNET CARBON DIOXIDE TRANSPORTATION AND STORAGE PROJECT - OFFSHORE

## Liverpool Bay CCS Ltd

**Environmental Statement**
**Volume 2, chapter 6: Physical Processes**

EHE7228B
Liverpool Bay CCS Limited
Final
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Offshore ES
Physical Processes

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|---|---|
| **RPS** | **Liverpool Bay CCS Limited** |

# Glossary

| Term | Meaning |
|---|---|
| Bathymetry | The measurement of water depth in oceans, seas and lakes. |
| Cumulative effect assessment | Assessment of the likely effects arising from the offshore components of the HyNet $CO_2$ Transportation and Storage Project -Offshore ('Proposed Development') alongside the likely effects of other development activities in the vicinity of the Proposed Development. |
| 'Do Nothing' Scenario | The environment as it would be in the future should the proposed project not be developed. |
| Ebb Tide | The tidal phase during which the water level is falling. |
| Effect | The consequence of an impact |
| Environmental Impact Assessment | A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report. |
| Environmental Statement | The document presenting the results of the Environmental Impact Assessment (EIA) process. |
| Impact | A change that is caused by an action |
| Inter-OP Cables | Cables to connect the Offshore Platforms (Ops) to each other |
| Intertidal Area | The area between Mean High-Water Springs (MHWS) and Mean Low Water Springs (MLWS). |
| Littoral Currents | Flow derived from tide and wave climate. |
| Magnitude | Size, extent, and duration of an impact. |
| Maximum Design Scenario | The maximum design parameters of each Proposed Development asset (both on and offshore) are considered to be a worst case for any given assessment but within the range of the Project Design Envelope. |
| Mean High Water | The highest water level reached during and average tide. |
| Mean High Water Spring | The most inshore level location reached by the sea at high tide during mean high water spring tide. This is defined as the average throughout the year, of two successive high waters, during a 24-hour period in each month when the range of the tide is at its greatest. |
| Mean Low Water Spring | The most offshore location reached by the sea at low tide during low water spring tide. This is defined as the average throughout the year, of two successive low waters, during a 24-hour period in each month when the range of the tide is at its greatest. |
| Mean Sea Level | The average tidal height over a long period of time. |
| Mitigation Measure | Measure which would avoid, reduce, or remediate an impact |
| Neap Tide | Tide that occurs when the sun and moon are at right angles to each other, and the gravitational pull of the sun partially cancels out the pull of the moon on the ocean. |
| Non-statutory stakeholder | Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development. |
| Project | The HyNet Carbon Dioxide Transportation and Storage Project. |
| Project Design Envelope (PDE) | Also known as the Rochdale Envelope, the PDE concept is routinely utilised in both onshore and offshore planning applications to allow for some flexibility in design options, particularly offshore, and more particularly for foundations and turbine type, where the full details of the project are not known at application submission but where sufficient detail is available to enable all environmental impacts to be appropriately considered during the EIA. |
| Project lifetime effects | Effects that occur throughout more than one phase of the project (construction, operations and maintenance, and decommissioning) interacting to potentially |

| Term | Meaning |
|---|---|
| | create a more significant effect upon a receptor than if just assessed in isolation in a single phase. |
| Proposed Development | The offshore components of the Project which are subject of this Environmental Statement, as described in Chapter 3. |
| Receptor-led effects | Effects that interact spatially and/or temporally resulting in inter-related effects upon a single receptor. |
| Residual Current | The net flow over the course of the tidal cycle. This is effectively the driving force of the sediment transport. |
| Residual Impact | Residual impacts are the final impacts that occur after the proposed mitigation measures have been put into place, as planned. |
| Scoping Opinion | Sets out the Secretary of State's response to the Applicants Scoping Report and contains the range of issues that the Secretary of State, in consultation with statutory stakeholders, has identified should be considered within the EIA. |
| Sedimentation | The process of settling or being deposited as a sediment. |
| Spring Tide | Tide that occurs when the sun and moon are directly in line with the Earth and their gravitational pulls on the ocean reinforce each other. |
| The Applicant | This is Liverpool Bay CCS Ltd. |
| Transboundary effects | Impacts from a project within one state affect the environment of another state(s). |
| Turbidity | The quality of being cloudy, opaque, or thick with suspended matter. |

# Acronyms and Initialisations

| Acronym / Initialisation | Description |
|---|---|
| ADD | Acoustic Deterrent Device |
| AIS | Automatic Identification System |
| AL1 | Action Level 1 |
| As | Arsenic |
| BEIS | The Department for Business, Energy and Industrial Strategy, now replaced by the Department for Energy Security and Net Zero. |
| BSI | British Standards Institute |
| BODC | British Oceanographic Data Centre |
| CA | Competent Authority |
| CCC | Committee on Climate Change |
| CCS | Carbon Capture and Storage |
| Cd | Cadmium |
| CEA | Cumulative Effects Assessment |
| CERMS | Cell Eleven Regional Monitoring Strategy |
| Cefas | Centre for Environment, Fisheries and Aquaculture Science |
| CIEEM | Chartered Institute of Ecology and Environmental Management |
| CoCP | Code of Construction Practice |
| $CO_2$ | Carbon Dioxide |
| COWRIE | Collaborative Offshore Wind Energy Research into the Environment |
| Cr | Chromium |
| CtL | Consent to Locate |
| CTV | Crew Transfer Vessel |
| Cu | Copper |
| DCO | Development Consent Order |

| Acronym / Initialisation | Description |
|---|---|
| DDV | Drop Down Video |
| DECC | The Department of Energy and Climate Change, merged with the Department for Business, Innovation and Skills, to form the Department for Business, Energy and Industrial Strategy. |
| DEFRA | The Department for Environment, Food and Rural Affairs |
| DESNZ | The Department for Energy Security and Net Zero, preceded by the Department for Business, Energy, and Industrial Strategy (2016 to 2023) and the Department of Energy and Climate Change (2008 to 2016) |
| DMRB | Design Manual for Roads and Bridges |
| DO | Dissolved Oxygen |
| DR | Drilling |
| EAJ | Environmental Assessment Justification |
| EC | European Commission |
| EcIA | Ecological Impact Assessment |
| ECMWF | European Centre for Medium-range Weather Forecast |
| EEA | European Economic Area |
| EIA | Environmental Impact Assessment |
| EMF | Electromagnetic Field |
| EMODnet | European Marine Observation and Data Network |
| EMP | Environmental Management Plan |
| Eni | Eni UK Limited |
| EPA | Environmental Protection Agency |
| EPS | European Protected Species |
| ES | Environmental Statement |
| ESCA | European Subsea Cables UK Association |
| EMODnet | European Marine Observation and Data Network |
| FO | Fibre Optic |
| GHG | Greenhouse gas |
| GSI | Geological Survey Ireland |
| HDD | Horizontal Directional Drilling |
| Hg | Mercury |
| HRA | Habitats Regulations Appraisal |
| ICPC | International Cable Protection Committee |
| IDC | Industrial Decarbonisation Challenge |
| IEMA | Institute of Environmental Management and Assessment |
| INFOMAR | Integrated Mapping for the Sustainable Developments of Ireland’s Marine Resource |
| JNCC | the Joint Nature Conservation Committee |
| KIS-ORCA | Kingfisher Information Service – Offshore Renewables and Cable Awareness |
| LSE | Likely Significant Effects |
| MAFF | Ministry of Agriculture, Fisheries and Food |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MCA | Maritime and Coastguard Agency |
| MAT | Master Application Template |
| MBES | Multibeam Echo Sounder |

| Acronym / Initialisation | Description |
|---|---|
| MEDIN | Marine Environmental Data Information Network |
| MCAA | Marine and Coastal Access Act |
| MCZ | Marine Conservation Zone |
| MDS | Maximum Design Scenario |
| MFE | Mass Flow Excavator |
| MHWS | Mean High Water Springs |
| MLWS | Mean Low Water Springs |
| MMO | Marine Management Organisation |
| MMV | Monitoring, Measuring and Verification |
| MPCP | Marine Pollution Contingency Plan |
| MPMMG | Marine Pollution Monitoring Management Group |
| Ni | Nickel |
| NOAA | National Oceanic and Atmospheric Administration |
| NPS | National Policy Statement |
| NRA | Navigational Risk Assessment |
| NRW | Natural Resources Wales |
| NRW-MLT | Natural Resources Wales – Marine Licencing Team |
| NSTA | North Sea Transition Authority, preceded by the Oil and Gas Authority |
| OGA | Oil and Gas Authority, replaced by the North Sea Transition Authority in March 2022 |
| OP | Offshore Platform |
| OPRED | Offshore Petroleum Regulator for Environment and Decommissioning |
| OSPAR | Oslo Paris Convention |
| P&A | Plugging and Abandonment |
| PAH | Polycyclic Aromatic Hydrocarbon |
| Pb | Lead |
| PCB | Polychlorinated Biphenyls |
| PDE | Project Design Envelope |
| PEIR | Preliminary Environmental Information Report |
| PINS | the Planning Inspectorate |
| PoA | Point of Ayr |
| PPG | Pollution Prevention Guidelines |
| PSA | Particle Size Analysis |
| PWA | Pipeline Works Authorisation |
| REA | Regional Environmental Assessment |
| RIAA | Report to Inform Appropriate Assessment |
| ROFI | Region of Freshwater Influence |
| RYA | Royal Yachting Association |
| SAC | Special Area of Conservation |
| SAT | Subsidiary Application Template |
| SPA | Special Protection Area |
| SSC | Suspended Sediment Concentration |
| SLA | Service Level Agreement |
| SMP | Shoreline Management Plan |
| SNCB | Statutory Nature Conservation Body |

| Acronym / Initialisation | Description |
|---|---|
| SPM | Suspended Particulate Matter |
| SSS | Sidescan Sonar |
| SSSI | Site of Special Scientific Interest |
| TCE | The Crown Estate |
| TCPA | Town and Country Planning Act |
| THC | Total Hydrocarbon Content |
| UK | United Kingdom |
| UKCP | UK Climate Projections |
| UKCS | United Kingdom Continental Shelf |
| UKHO | United Kingdom Hydrographic Office |
| UNECE | United Nations Economic Commission for Europe |
| UXO | Unexploded ordnance |
| WFD | Water Framework Directive |
| Zn | Zinc |
| ZOI | Zone Of Influence |

# Units

| Unit | Description |
|---|---|
| % | Percent |
| cm | Centimetre (distance) |
| g | Gram |
| Hz | Hertz |
| km | Kilometres |
| $km^2$ | Kilometres squared |
| kV | Kilovolt (electrical potential) |
| kW | Kilowatt (power) |
| m | Metres (distance) |
| mm | millimetre |
| $m^2$ | Metres squared (area) |
| $m^3$ | Metres cubed (volume) |
| $m^3$/d/m | Metres cubed per day per metre width |
| m/s | Metres per second (speed) |
| mg/l | Milligram per litre (concentration) |
| MW | Megawatt |
| NM | Nautical Mile (distance; equal to 1.852 km) |
| µg/kg | Micrograms per kilogram |

# Contents

## Tables



## Figures

# 6 PHYSICAL PROCESSES

## 6.1 Introduction

This chapter of the Offshore Environmental Statement (ES) presents the assessment of the likely significant effects (as per The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, '2020 EIA Regulations') on the environment of the Proposed Development on the offshore physical processes. Specifically, this chapter considers the potential impacts from the construction, operation and maintenance, and decommissioning of the offshore and intertidal components (seaward of the Mean High Water Springs (MHWS) mark) of the Eni development area, which includes the pipelines and cables leading to MHWS.

Likely significant effect is a term used in both the '2020 EIA Regulations' and the Habitat Regulations. Reference to likely significant effect in this Offshore ES refers to likely significant effect as used by the '2020 EIA Regulations'. This Offshore ES is accompanied by a Report to Inform Appropriate Assessment (RIAA) which uses the term as defined by the Habitats Regulations Appraisal (HRA) Regulations.

The assessment presented informs the following technical chapters and reports:

- volume 2, chapter 7: Marine Biodiversity; and
- volume 2, chapter 12: Infrastructure and Other Sea Users.

This chapter summarises information derived from the numerical modelling study contained within the Physical Processes Technical Report (RPS Group, 2024a).

## 6.2 Purpose of this chapter

The primary purpose of the Offshore ES is outlined in volume 1, chapter 1. It is intended that the Offshore ES will provide the statutory and non-statutory stakeholders, with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

In particular, this Physical Processes ES chapter:

- presents the existing environmental baseline established from desk studies, site-specific surveys, numerical modelling studies and consultation with stakeholders;
- identifies any assumptions and limitations encountered in compiling the environmental information;
- presents the likely significant environmental impacts on Physical Processes arising from the Proposed Development and reaches a conclusion on the likely significant effects on Physical Processes, based on the information gathered and the analysis and assessments undertaken; and
- highlights any necessary monitoring and/or mitigation measures which may be recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Proposed Development on Physical Processes.

## 6.3 Study area

The physical processes study area for the Proposed Development, as shown Figure 6.1, is defined as the area encompassing the area of project physical work, plus a buffer of one tidal excursion. The *c.*8 km buffer around the area of project physical work previously used in the EIA Scoping Report (RPS, 2022), has been updated on the basis of tidal ellipse modelling along the proposed cable route. The updated physical processes study area accounts for this tidal excursion and was extended to incorporate the potential for residual currents along the coastline, it therefore illustrates the areas potentially affected by changes in water quality (increases in Suspended Sediment Concentration (SSC)).

The physical processes study area forms the focus for the assessment, however the extent of the numerical models employed in undertaking the study was not limited to this region and would therefore also identify any potential impacts beyond the physical processes study area both further offshore and along the shoreline.

### 6.3.1 Intertidal area

The offshore topic of physical processes study area includes the intertidal area. This intertidal area overlaps with the onshore topics of Land and Soils, and Water Resources and Flood Risk (landward of Mean Low Water Springs (MLWS)).

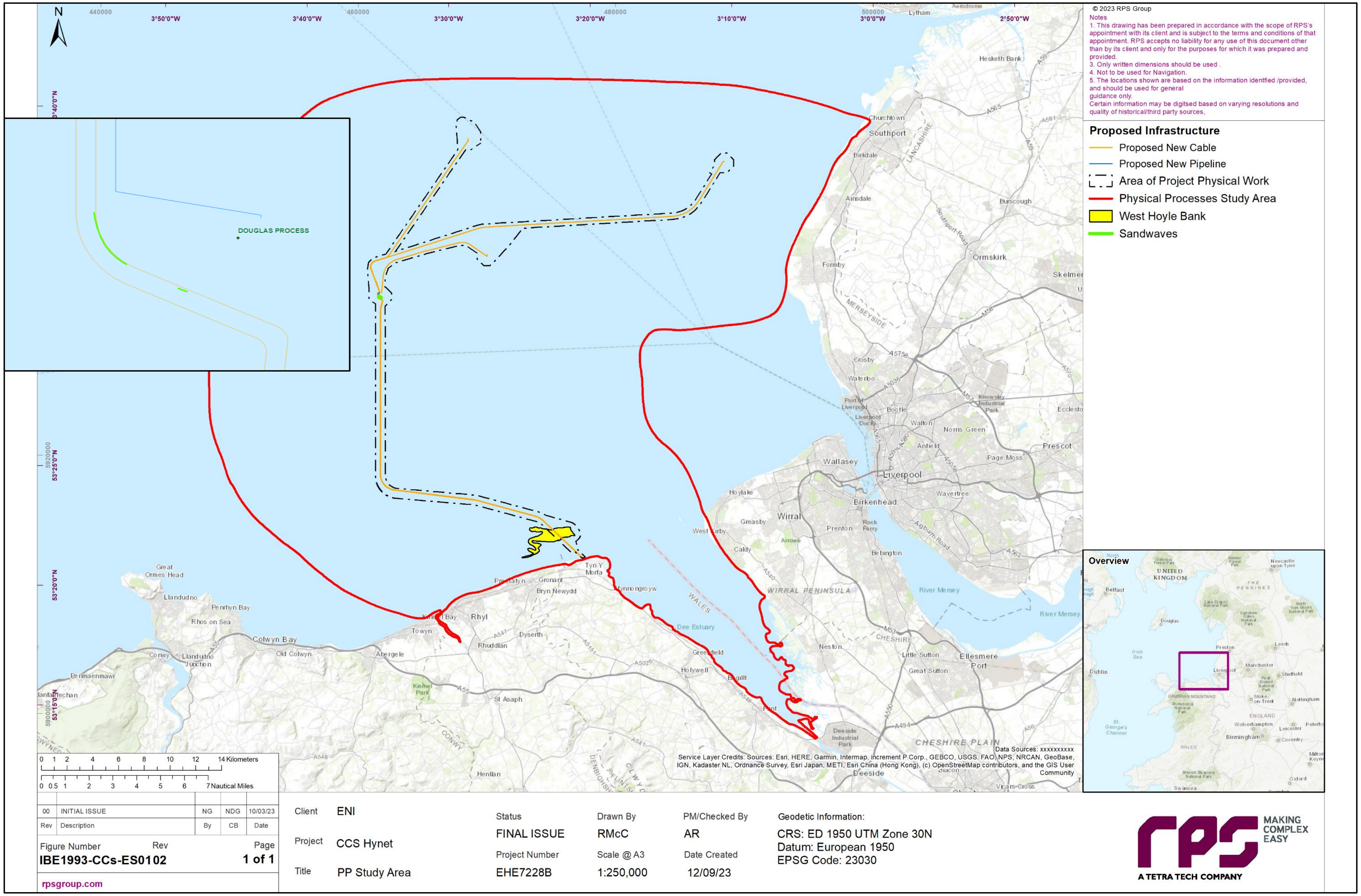


**Figure 6.1: Physical Processes Study Area (inset Sand Wave Locations South of Douglas OP)**

## 6.4 Policy and legislation

The policy context for the HyNet Carbon Dioxide Transportation and Storage Project- Offshore is set out in volume 1, chapter 2. Policy specifically in relation to physical processes, is contained in the North West Shoreline Management Plan (SMP) (Halcrow Group Limited, 2011), and the North West Inshore and North West Offshore Coast Marine Plans (DEFRA, 2021).

A summary of the SMP policy provisions relevant to Physical Processes are provided in Table 6.1, with other relevant policy provisions set out in Table 6.2.

These are summarised here with further detail presented in volume 3, Appendix D.

### 6.4.1 North West Shoreline Management Plan

The assessment of potential changes to physical processes has been made with consideration to the specific policies set out in the North West SMP (Halcrow Group Ltd., 2010). Key provisions are set out in Table 6.1 along with details as to how these have been addressed within the assessment where appropriate.

**Table 6.1: Summary of SMP Policies Relevant to Physical Processes**

| Location | Summary of SMP Provision | How and Where Considered in the Offshore ES |
|---|---|---|
| Clwyd Estuary (11a3) | The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across the subcell, up to 2030. In the longer term a policy of Managed Realignment is recommended at Forydd Railway Bridge to Rhuddlan Road Bridge Clwyd Estuary (East and West) in the interests of future habitat creation. | Impacts associated with changes in Suspended Sediment Concentrations (SSCs) and water quality have no pathway to impact on SMP policies. |
| Clwyd Estuary to Point of Ayr (11a4) | The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across a majority of the subcell. However, a provision of Managed Realignment is made for Barkby Beach to Point of Ayr, to allow natural processes to govern movement of the present dune system. | |
| Dee Estuary (11a5) | The SMP recommends a policy of Hold the Line via the maintenance and improvement of defences across the subcell, up to 2030. In the longer term a policy of Managed Realignment is recommended at Mostyn to Flint Marsh, and Sealand Rifle Range to Burton Point, with the interests of future habitat creation. | |
| Formby Dunes (11a9) | A policy of managed realignment is recommended in the SMP into the long term in favour of allowing natural processes to occur and encourage natural development of dune systems. | |

### 6.4.2 North West Inshore and North West Offshore Coast Marine Plans

The assessment of potential changes to physical processes has also been made with consideration to the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). Key provisions are set out in Table 6.2 along with details as to how these have been addressed within the assessment.

**Table 6.2: Summary of the North West Inshore and North West Offshore Coast Marine Plans Relevant to Physical Processes**

| Summary of Relevant Legislation | How and Where Considered in the Offshore ES |
|---|---|
| NW-CAB-1<br>Preference should be given to proposals for cable installation where the method of protection is burial.<br>Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures. | Details of the Proposed Development design criteria are detailed in volume 1, chapter 4. |
| NW-MPA-1<br>Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference:<br>a) avoid<br>b) minimise<br>c) mitigate - adverse impacts, with due regard given to statutory advice on an ecologically coherent network. | Designated sites and features of importance within the physical processes study area have been identified in section 6.7.12.<br>Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0. |
| NW-MPA-4<br>Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order of preference:<br>a) avoid<br>b) minimise<br>c) mitigate - adverse impacts so they are no longer significant. | Designated sites and sites of interest due to geological importance within the physical processes study area have been identified in section 6.7.12.<br>Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0. |
| NW-BIO-1<br>Proposals that may have significant adverse impacts on the distribution of priority habitats and priority species must demonstrate that they will, in order of preference:<br>a) avoid<br>b) minimise<br>c) mitigate - adverse impacts so they are no longer significant<br>d) compensate for significant adverse impacts that cannot be mitigated. | Sites identified as habitat directive Annex 1 habitats within the physical processes study area have been identified in section 6.7.12.<br>Potential impacts have also been identified and the significance of the effects on physical processes receptors has been assessed in section 0. Likewise impacts on marine biodiversity have been assessed in volume 2, chapter 7. |
| NW-CE-1<br>Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference:<br>a) avoid<br>b) minimise<br>c) mitigate - adverse cumulative and/or in- combination effects so they are no longer significant. | A CEA has been undertaken and is outlined in section 6.12.<br>Designated sites and sites of interest due to geological importance within the physical processes study area have been identified in section 6.7.12 |

## 6.5 Consultation

A summary of the key issues raised during consultation activities undertaken to date specific to Physical Processes is presented in Table 6.3 below, together with how these issues have been considered in the production of this Offshore ES chapter.

**Table 6.3: Summary of Key Consultation of Relevance to Physical Processes**

| Date | Consultee and Type of Response | Issue Raised | Response to Issue Raised and/or Where Considered in this Chapter |
|---|---|---|---|
| January 2023 | Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) Scoping Opinion | Study Area - It is advised that the maximum spring tidal excursion should be used to define the zone of influence. | The 8 km buffer used for the developing the physical processes study area for scoping used a preliminary assessment of tidal currents at the offshore extent of the project to determine the tidal excursion. A more detailed assessment has been undertaken to refine the spring tidal excursion during the modelling study. See section 6.3. |
| January 2023 | OPRED Scoping Opinion | Activities omitted from the scoping of potential impacts:<br>• the potential for cable protection along the cable corridor;<br>• the use of concrete mattresses across three potential cable crossings; and<br>• the potential to protect the Horizontal Directional Drilling (HDD) exit pits located in the intertidal zone. | These activities are now included in the proposed development description outlined in volume 1, chapter 3. Cable protection is to be utilised, in the form of cable crossings, up to 10% cable routes, however, is to have a profiled cross-section and <1 m in height to minimise impacts on physical processes and sediment transport pathways.<br>The HDD exit pit will be 3 m below beach level (just above the MHWS line), therefore there will be no requirement for external protection. |
| January 2023 | OPRED Scoping Opinion | The presence of cable protection may alter the current and wave regime and alter the sediment transport pathways, particularly if located in shallow water. Consideration should also be given to the potential for secondary scour. | Cable protection, in the form of cable crossings, is to be utilised along up to 10% of cable routes, however, is to have a profiled cross-section <1 m in height to minimise impacts on physical processes and sediment transport pathways., |
| January 2023 | OPRED Scoping Opinion | Further information on the presence of any sand wave features in the area, including sand wave height, length and migratory rate should be included in order to further understand the potential impacts. Although the project does not involve dredging, clarification is required on whether any sand wave clearance will take place as part of the | Since scoping the PDE has been updated to include potential dredging along a channel through West Hoyle Bank, the details of which are presented in section 6.11.1.<br>Likewise, the PDE has since been updated to include the clearance of 115 m of sand waves south of the Douglas OP. The details and impacts of which are presented in section 6.11.1. |

| Date | Consultee and Type of Response | Issue Raised | Response to Issue Raised and/or Where Considered in this Chapter |
|---|---|---|---|
| | | cable laying activities. Should sand wave clearance be required then consideration should be given to the potential impacts on the seabed bed morpho-dynamics (i.e. sand banks and migrating sand wave fields). | |
| January 2023 | OPRED Scoping Opinion | Stratification influences the hydrodynamic and sediment transport regimes within Liverpool Bay, and it is recommended that the impact assessment for the project should consider the effects of stratification on sediment transport within the Eni development area, with particular emphasis on the seasonal variability in impacts. | The nature of this proposed development, laying cables in trenches following previously installed infrastructure, would not influence the mechanisms which cause stratification. There are no elements within the water column to disrupt stratification and no changes in tidal regime. |
| January 2023 | OPRED Scoping Opinion | It is recommended that Physical Processes are treated as a separate chapter of the ES with any cross links between chapters clearly indicated. | This is in line with the methodology adopted in this chapter. See section 6.6. |
| January 2023 | OPRED Scoping Opinion | It is advised that a conceptual understanding of the baseline environment for physical processes is established so that the potential impacts caused by the activities resulting from the project can be properly assessed. It is recommended that Natural Resource Wales (NRW) Marine Physical Processes Guidance is used to inform the ES when conducting the proposed site surveys detailed in section 1.2. | This is in line with the methodology adopted in this chapter. See section 6.6. |
| January 2023 | OPRED Scoping Opinion | It is recommended that the British Oceanographic Data Centre (BODC) and iMarDIS SEACAMS data portal is included in the desktop data sources to Inform the Physical Processes Scoping Assessment. | Additional data sources which informed the assessment have been detailed in Table 6.4. See section 6.6. |
| January 2023 | OPRED Scoping Opinion | Physical processes are considered to be a pathway for other receptors, whilst also being a receptor in their own right (e.g. sand bank features, beaches and coast). The strong links between water quality and | This is in line with the proposed approach. Water Quality is presented in a separate section within the physical processes chapter drawing from the WFD Assessment volume 3, appendix Q and section 6.7.11) and physical processes studies. |

| Date | Consultee and Type of Response | Issue Raised | Response to Issue Raised and/or Where Considered in this Chapter |
|---|---|---|---|
| | | suspended sediment concentration (SSC) are recognised, however, it is recommended that physical processes are treated within a separate chapter, with any cross-linkages between chapters clearly signposted. | |
| January 2023 | OPRED Scoping Opinion | Activities relating to cable protection measures should be scoped in for the construction, operation, and maintenance phases of the project. | Cable protection is to be utilised, in the form of cable crossings, along up to 10% of cable routes, however, is to have a profiled cross-section and <1 m in height to minimise impacts on physical processes and sediment transport pathways. |
| January 2023 | OPRED Scoping Opinion | Clarification is sought as to whether the exit pits will require rock armour protection. | The HDD exit pit will be 3 m below beach level (just above the MHWS line), therefore there will be no requirement for external protection. |
| January 2023 | OPRED Scoping Opinion | The Developer should ensure that the ES provides clarification on how (and to what extent) suspended sediment concentrations can impact the local tidal regime and wave climate and provide details of any proposed mitigation measures. | Numerical modelling was used to quantify the dispersion and settlement of the mobilised sediment. Increased SSC will not change either the wave or tidal regimes. |
| January 2023 | OPRED Scoping Opinion | The Dee is a Region of Freshwater Influence (ROFI) which modulates the levels of stratification in the Liverpool Bay area. Therefore, this section should consider the impacts of stratification on sediment transport within the Eni development area, with particular emphasis on the seasonal variability in impacts. | The nature of this proposed development, laying cables in trenches following previously installed infrastructure, would not influence the mechanisms which cause stratification. There are no elements proposed within the water column of sufficient scale to disrupt stratification and no changes in tidal regime. |
| January 2023 | OPRED Scoping Opinion | Appropriate validation and calibration of any sediment dispersal/ transport model is also requested and reference to Natural Resources Wales Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA) is also recommended. | This is in line with the proposed approach. Model verification data is presented in the Physical Processes Technical Report (volume 3, appendix H). |
| January 2023 | OPRED Scoping Opinion | It is recommended that Marine Water and Sediment Quality are included as separate topics and are assessed as such. | This is in line with the proposed approach. Water quality is presented within the physical processes chapter drawing from the WFD assessment (volume 3, |

| Date | Consultee and Type of Response | Issue Raised | Response to Issue Raised and/or Where Considered in this Chapter |
|---|---|---|---|
| | | | appendix Q) and physical processes studies. |
| January 2023 | OPRED Scoping Opinion | It is advised that the ES includes information on the sediment quality and the potential for any effects on water quality through suspension of contaminated sediments. The ES should also consider whether increased SSC have the potential to impact upon interest features and supporting habitats of any designated sites. | This is in line with the methodology adopted in this chapter. See section 6.6. |
| January 2023 | OPRED Scoping Opinion | The following potential impact pathways for marine water and sediment quality which are not currently scoped-in but which will require further consideration have been identified: bacterial release from sediments due to the proximity of designated bathing and shellfish waters; pipeline contents temperature effects; and impacts to Dissolved Oxygen and Phytoplankton as a result of elevated suspended sediment concentrations. | Impacts related to water quality are discussed in section 6.11.3. |
| January 2023 | OPRED Scoping Opinion | No background information has been provided for water quality. It is recommended that this is included. | This is presented in the WFD Assessment (section 6.7.11 and volume 3, appendix Q) |
| January 2023 | OPRED Scoping Opinion | It is advised that accidental releases during maintenance operations are also considered in Table 6.2. | In the modelled scenarios all potentially mobilised sediment is included and following impacts related to physical processes are discussed in section 6.11.1. |
| January 2023 | OPRED Scoping Opinion | Potential increased temperature effects from the pipeline contents should be considered as part of the marine water and sediment quality assessment. | The proposed pipeline will be buried and therefore temperature increases will have no impact to physical processes. Impacts related to benthic ecology are discussed in volume2, chapter 7. |
| January 2023 | OPRED Scoping Opinion | As a result of elevated suspended sediment concentration as a result of the activities it is advised that impacts to dissolved oxygen (DO) and phytoplankton are assessed. | Impacts related to water quality are discussed in section 6.11.3 |
| December 2023 | NRW Fitness Check Response | Issues raised include:<br>1. Assessment methodology relating to magnitude and sensitivity | Addressed in:<br>1. Section 6.6 and 6.9<br>2. Section 6.7<br>3. Section 6.8 |

| Date | Consultee and Type of Response | Issue Raised | Response to Issue Raised and/or Where Considered in this Chapter |
|---|---|---|---|
| | | does not follow NRW guidance;<br>2. Insufficient evidence to accurately describe the baseline environment;<br>3. Disagree with scoping pathways for seabed morphology;<br>4. Incomplete justification of secondary scour from cable protection measures;<br>5. No detail on the requirement for cable protection during operation or maintenance.<br>6. Incomplete detail on modelling calibration and validation.<br>7. Quantitative data should be used to assess cumulative effect and Mostyn Dock development should be included. | 4. Section 6.11<br>5. See Chapter 3, Section 3.5.2, and Section 6.11<br>6. See volume 3, appendix H<br>7. Section 6.13 |

# 6.6 Methodology to inform the baseline

## 6.6.1 Data sources

A desktop study was undertaken to inform the baseline, using a range of relevant publications, modelling studies, and publicly available data sources, as it described in the section below.

## 6.6.2 Desktop study

Information regarding the physical processes within Liverpool Bay has been collated through a detailed and comprehensive review of currently accessible studies and datasets. To provide a wider context, the desktop review has also considered the broader area of the Irish Sea in proximity to the Eni development area. The baseline has been established through the use of data on bathymetry, geology, seabed sediments, sediment quality and contamination, suspended sediments, tidal regime, sediment transport, and waves. Key data sources, including those used within the Technical Report to inform modelling studies, are listed in

Table 6.4 below.

**Table 6.4: Summary of Key Desktop Reports used within the ES and Technical Report**

| Title | Source | Year | Author |
|---|---|---|---|
| Mona Offshore Wind Project Generation Assets Preliminary Environmental Information Report (PEIR) - Technical Report | https://www.morganandmona.com/en/consultationhub/ | 2023 | RPS Group |
| Morgan Offshore Wind Project Generation Assets Preliminary Environmental Information Report (PEIR) - Technical Report | https://morecambeandmorgan.com/morgan/consultationhub/ | 2023 | RPS Group |
| European Marine Observation and Data Network (EMODnet) – Seabed classification | https://www.emodnet-geology.eu/ | 2023 | EMODnet |
| European Marine Observation and Data Network (EMODnet) – Bathymetry data | https://www.emodnet-bathymetry.eu/ | 2023 | EMODnet |
| European Marine Observation and Data Network (EMODnet) – Metocean data | https://map.emodnet-physics.eu/ | 2023 | EMODnet |
| Department for Environment Food and Rural Affairs (DEFRA) – Bathymetry data | https://environment.data.gov.uk/DefraDataDownload | 2023 | DEFRA |
| The Environment Agency National LiDAR Programme | National LIDAR Programme - data.gov.uk | 2022 | Environment Agency |
| National Oceanic and Atmospheric Administration (NOAA) – Atmospheric data | DHI Metocean Data Portal | 2022 | NOAA |
| National Network of Regional Coastal Monitoring Programmes | https://coastalmonitoring.org/cco/ | 2022 | Coastal Channel Observatory |
| Centre for Environment, Fisheries and Aquaculture Science (Cefas) – wave data | https://wavenet.cefas.co.uk/map | 2022 | CEFAS |
| ABPmer Data explorer | https://www.seastates.net/explore-data/ | 2023 | ABPmer |

| Title | Source | Year | Author |
|---|---|---|---|
| Hydrography of the Irish Sea, SEA6 Technical Report | UK Government | 2005 | Howarth M.J. |
| Atlas of UK Marine Renewable Energy Resources | https://www.renewables-atlas.info/ | 2022 | ABPmer |
| Geology of the seabed and shallow subsurface: The Irish Sea. | British Geological Survey | 2015 | Mellett *et al*. |
| British Geological Survey – sediment sample data | https://mapapps2.bgs.ac.uk/geoindex_offshore | 2022 | BGS |
| Suspended Sediment Climatologies around the UK. | Department for Business, Energy & Industrial Strategy (BEIS) | 2016 | Cefas |
| Metocean Data collection for the Ormonde offshore wind project. | Marine Data Exchange | 2011 | Geotechnical Engineering and Marine Surveys (GEMS) |
| Irish Sea Zone Hydrodynamic measurement campaign | Marine Data Exchange | 2010 to 2013 | EMU Ltd (now Fugro Ltd) |
| Admiralty Tide Tables | United Kingdom Hydrographic Office (UKHO) | 2023 | UKHO |
| Marine Environmental Data Information Network (MEDIN) Seabed Mapping Programme | Admiralty Marine Data Portal | 2022 | MEDIN |
| Integrated Mapping for the Sustainable Developments of Ireland's Marine Resource (INFOMAR) Seabed Mapping Programme | Geological Survey Ireland (GSI) and Marine Institute | 2022 | INFOMAR |
| Long term wind and wave datasets | European Centre for Medium-range Weather Forecast (ECMWF) | 2022 | ECMWF |
| UK tide gauge network and database of current observation | British Oceanographic Data Centre (BODC) | 2021 | BODC |
| UK Climate Projections (UKCP) | Met Office | 2018 | Met Office |
| Review of aggregate dredging off the Welsh coast | HR Wallingford | 2016 | HR Wallingford |

| Title | Source | Year | Author |
|---|---|---|---|
| Transport and deposition of sediment-associated *Escherichia coli* in natural streams. | Scientific Data (journal) | 2005 | Jamieson et al |
| A user-friendly database of coastal flooding in the UK from 1915-2014 | Scientific Data (journal) | 2015 | Haigh *et al*. |
| Awel y Môr Offshore Windfarm PEIR and ES | Awel y Môr Offshore Wind Farm Ltd. | 2021 & 2022 | RWE Renewables |
| Burbo Bank Extension Offshore Windfarm Environmental Statement | https://www.marinedataexchange.co.uk/ | 2013 | Ørsted |
| Walney Extension Offshore Wind Farm Environmental Statement | https://www.marinedataexchange.co.uk/ | 2013 | Ørsted |
| Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended), Regulation 22 – EIA Consent Decision. Marine aggregate extraction Area 392/393, known as Hilbre Swash | https://naturalresources.wales/?lang=en | 2013 | NRW |
| Natural Variability of Turbidity in the Regional Environmental Assessment (REA) Areas. | https://www.marinedataexchange.co.uk/ | 2011 | MALF |
| North West England and North Wales SMP22 - SMP2 | http://www.hoylakevision.org.uk/wp-content/uploads/2012/11/SMP2Main.pdf | 2011 | Halcrow Group Ltd |
| Cell Eleven Tidal and Sediment Study Phase 2 | https://coastalmonitoring.org/ | 2010 | Halcrow Group Ltd |
| Cell Eleven Regional Monitoring Strategy (CERMS) | https://coastalmonitoring.org/ | 2010 | Halcrow Group Ltd |
| Walney 1 & 2 Offshore Windfarm Environmental Statements | https://www.marinedataexchange.co.uk/ | 2006 | Ørsted |

| Title | Source | Year | Author |
|---|---|---|---|
| West of Duddon Sands Offshore Windfarm Environmental Statement | https://www.marinedataexchange.co.uk/ | 2006 | RSK Environment Ltd |
| DTI Strategic Environmental Assessment Area 6, Irish Sea, seabed and surficial geology and processes | British Geological Survey | 2005 | Holmes and Tappin |
| Ormonde Offshore Windfarm Environmental Statement | https://www.marinedataexchange.co.uk/ | 2005 | Rudall Blanchard Associates |
| Barrow Offshore Windfarm Environmental Statement | https://www.marinedataexchange.co.uk/ | 2005 | Royal Haskoning DHV |
| Mostyn Energy Park Extension (MEPE) Environmental Statement Chapter 6: Physical Processes. | https://publicregister.naturalresources.wales/ | 2022 | ABPmer |
| iMarDIS Portal | https://portal.imardis.org/ | 2023 | iMarDIS |
| Designated sites (Special Protection Areas (SPAs) and Special Areas of Conservation (SACs)) | JNCC mapping data (https://jncc.gov.uk/mpa-mapper/) | 2023 | JNCC |
| Designated sites (Sites of Special Scientific Interest (SSSIs)) | DEFRA Spatial Data Download | 2023 | DEFRA |
| Designated Ramsar sites | https://rsis.ramsar.org/ris/937 | 2023 | Ramsar |

### 6.6.3 Site-specific surveys

In order to inform the ES, site-specific surveys were undertaken, as agreed with the OPRED, NRW, MMO, JNCC, NE, NSTA, Trinity House, MoD, MCA and Cefas. A summary of the surveys undertaken to inform the physical processes impact assessment is outlined in Table 6.5, with the bathymetry survey illustrated in Figure 6.2.

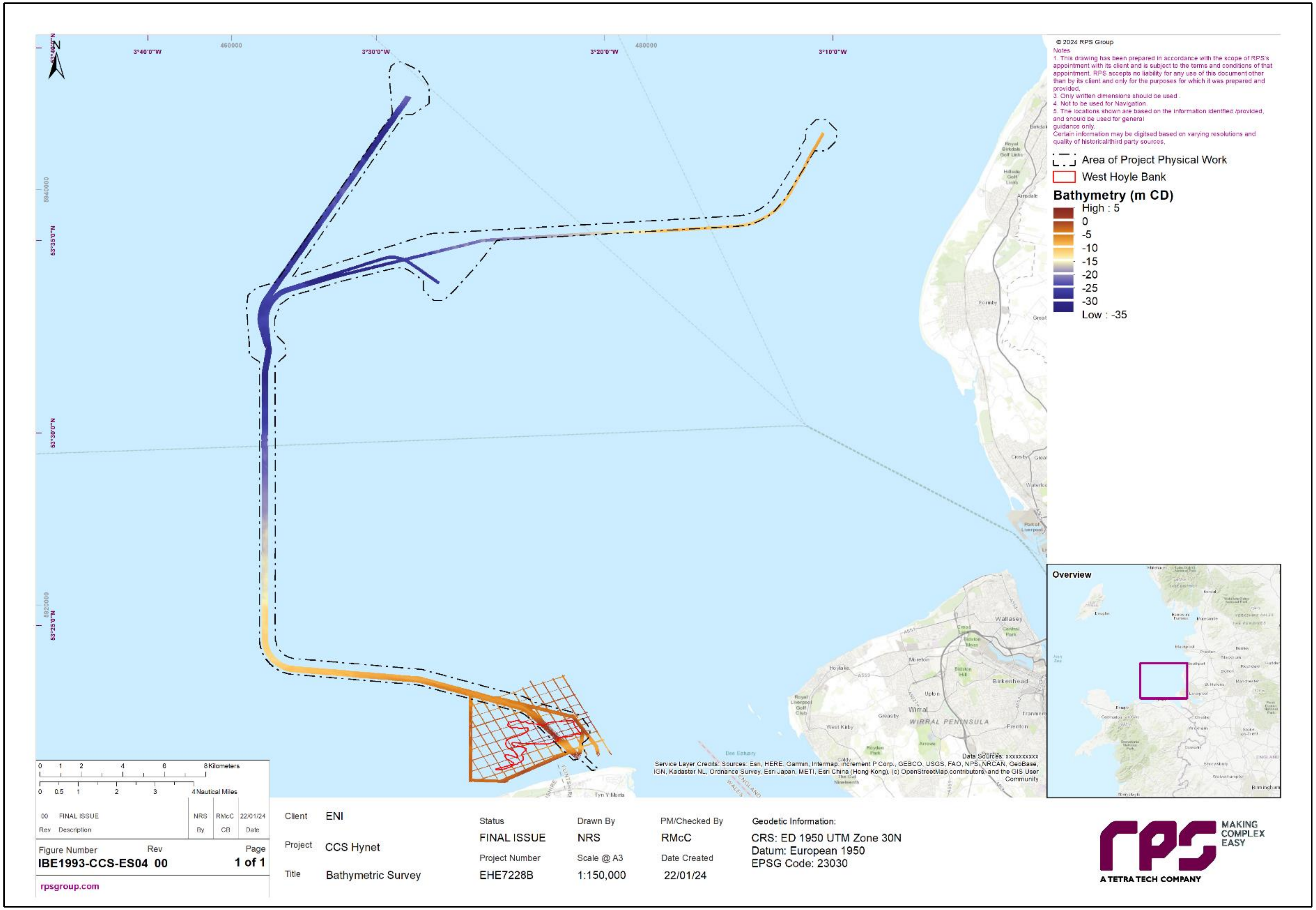


**Figure 6.2: Detailed Bathymetric Survey of the Proposed Development Cable Path**

**Table 6.5: Summary of Site-specific Survey Data.**

| Title | Extent of Survey | Overview of Survey | Survey Contractor | Date |
|---|---|---|---|---|
| HyNet Carbon Capture Storage and Decommissioning Benthic Survey Report 2022 | Project area of physical work | Benthic/ sedimentary survey carried out via seabed imagery and grab sampling utilised for Particle Size Analysis (PSA) | Ocean Ecology Ltd. | 2022 |
| Sidescan sonar | Within the Area of Project Physical Work (APPW) and Hoyle Bank | Sidescan Sonar survey to characterise seabed and existing assets | James Fisher Subtech (JFS) | 2022 |
| Multibeam | Within the APPW and Hoyle Bank | Survey to characterise seabed and existing assets | JFS | 2022 |
| Magnetometer | Within the APPW and Hoyle Bank | Survey to characterise seabed and existing assets | JFS | 2022 |
| Sub-bottom Profiler | Within the APPW and Hoyle Bank | Survey to characterise seabed and existing assets | XOcean | 2022 |

## 6.6.4 Establishing Baseline Environment

The characteristics of each of the physical processes outlined in *Marine Physical Processes Guidance to inform Environmental Impact Assessment* was completed (NRW, 2020) (Table 6.6).

**Table 6.6: Physical Processes as per NRW Guidance**

| Category | Data Requirement |
|---|---|
| Hydrodynamics | Tidal regime (water level range, current speed and direction) (See Section 6.7.5)<br>Wind Wave and Swell (wave height, period and direction) (See Section 6.7.6)<br>Residual water movement; (See Section 6.7.9)<br>Surge Water Levels and Current (See Section 6.7.5) |
| Sediments and Geology | Characteristics of seabed sediments (See Section 6.7.7)<br>Particle size and density (See Section 6.7.7)<br>Lithology (origin, composition) (See Section 6.7.7)<br>Thickness of sediment units (See Section 6.7.4 and 6.7.7)<br>Suspended sediment concentrations (See Section 6.7.10)<br>Seabed mobility (See Section 6.7.3 and 6.7.9)<br>Sediment transport pathways and rates (See Section 6.7.9) |
| Topography / Morphology | Bathymetry (See Section 6.7.2)<br>Bedforms and notable seabed features (See Section 6.7.2 and 6.7.3)<br>Coastal topography, configuration and notable features (See Section 6.7.2) |

By outlining further characteristics collected and identified during the completion of the accompanying in volume 3, appendix H this allows a further refined conceptual understanding of the physical processes study area. The summary of this consultation response from NRW is outlined in Table 6.3.

# 6.7 Existing baseline description

## 6.7.1 Overview of baseline environment

A summary of the physical processes baseline environment is provided in the following sections. Full details of the analysis undertaken to develop the physical processes baseline is provided in Physical Processes Technical Report (RPS Group, 2024a), which includes information on model development, resolution, calibration, and the modelling techniques implemented to develop the baseline characteristics.

## 6.7.2 Bathymetry

The proposed Eni development area includes the Point of Ayr (PoA) Terminal to Douglas Offshore Platform (OP) pipeline, leading to Talacre Beach, is situated in water depths of 0.72 m (nearshore) to 35 m (offshore) referenced to Mean Sea Level, with average water depths across the Eni development area being approximately 20 m. Particularly shallow depths occur along the proposed PoA to Douglas OP cable route, specifically across West Hoyle Bank which is a drying area. The Douglas OP and Lennox OP terminals are situated in 29.20 m and 7.20 m of water respectively. Shallower water is generally present towards the southern and eastern boundaries of the area of project physical work. Figure 6.3 displays the bathymetry in the model domain. Data was collected from online sources including MEDIN (2022), Infomar (2022), (EMODnet (2023), Defra (2022). Environment Agency (2022) and site specific surveys. The geophysical survey was conducted by James Fisher Subtech (JFS) between 12 September and 30 November 2022 as part of the wider Liverpool Bay Asset and Carbon Capture Storage Acoustic Surveys 2022 Campaign. The surveys resulted in the mobilisation of a Multibeam Echo Sounder (MBES), a Sidescan Sonar (SSS), and a Magnetometer. The SSS, and Magnetometer were towed behind the vessel, the MBES was mounted to the vessels.

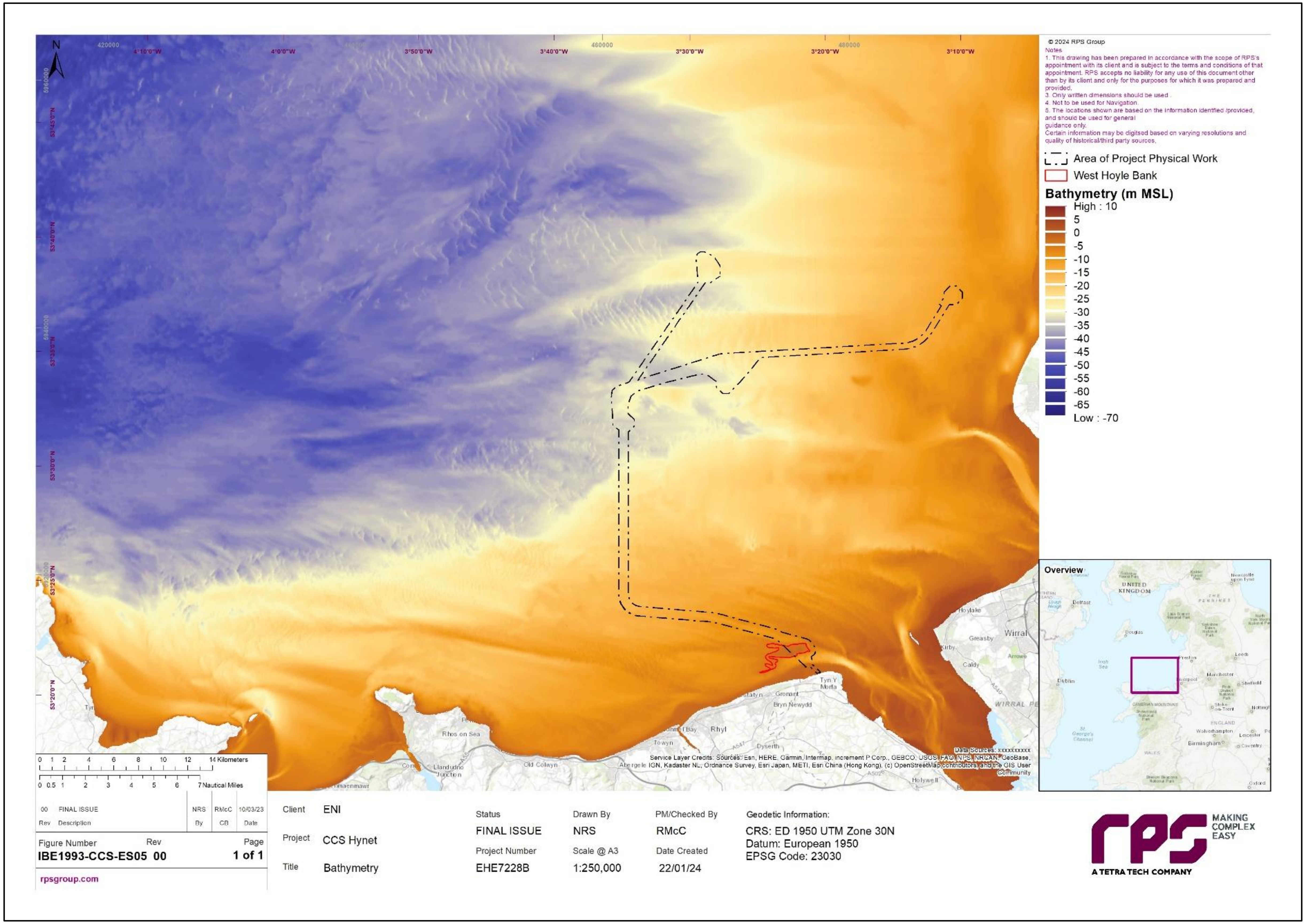


**Figure 6.3: Bathymetry Data Utilised in Numerical Modelling within the East Irish Sea**

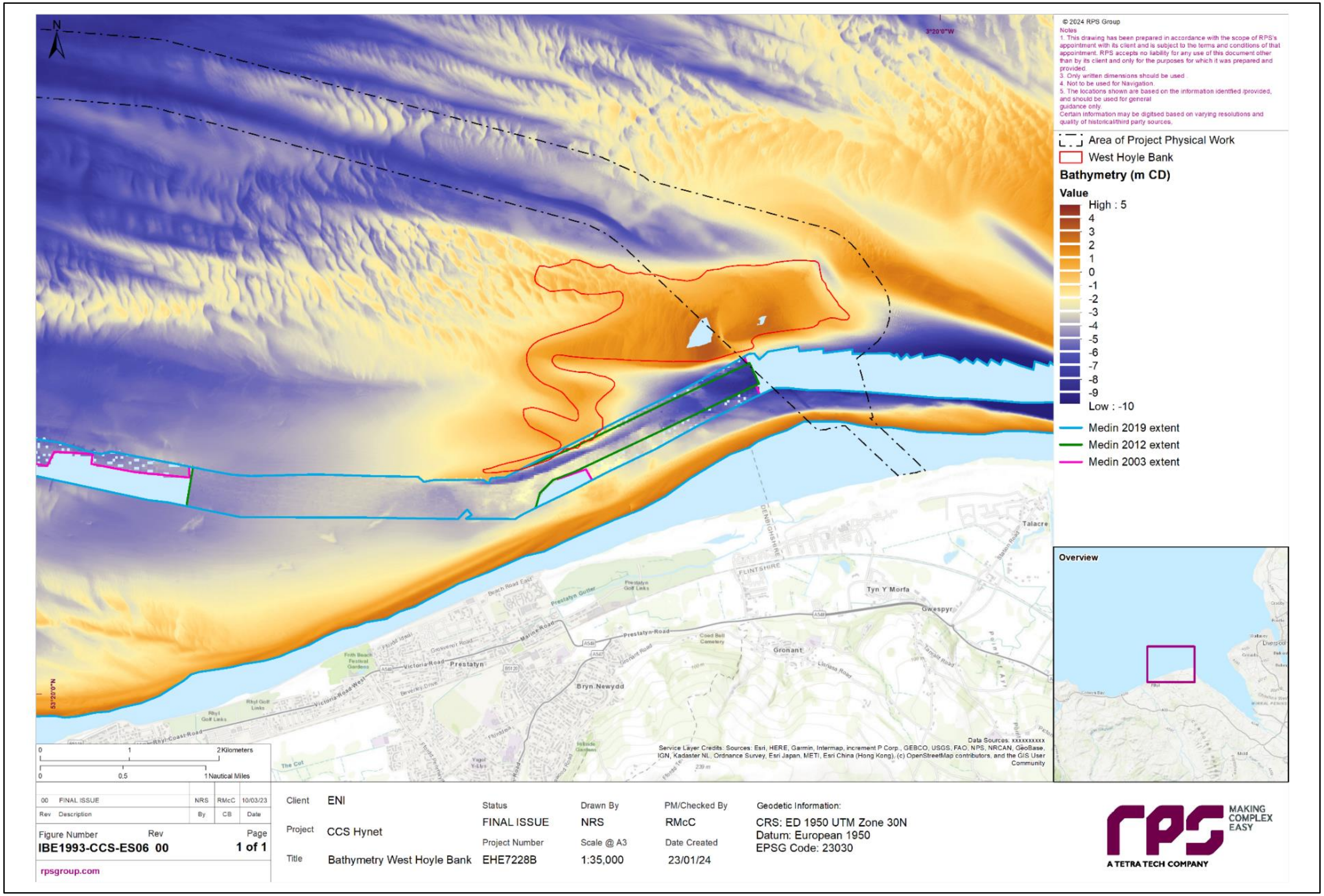


**Figure 6.4: Bathymetry Data Utilised in Numerical Modelling - West Hoyle Bank**

### 6.7.3 West Hoyle Bank

West Hoyle Bank is a sandbank of geomorphological and geological importance outside the mouth of the Dee Estuary (Figure 6.4). Although West Hoyle Bank is not a designated site, it is however a site of importance as it is a sandbank which meets the Annex 1 habitat criteria of the EC Habitats Directive (Council Directive 92/43/EEC) (EC, 1992) and acts as a natural breakwater.

Sandbanks can be highly mobile driven by tides rather than waves and the formation is reliant on the availability of sediment. The shallow shifting sandbank at West Hoyle Bank is notoriously dynamic and bathymetric change across the mouth of the Dee Estuary is commonplace. West Hoyle Bank is understood to influence the exchange of sediments with the adjacent coastline and the wave climate approaching the coastline, the removal of this feature therefore has the potential to create a coastal flood risk through increased wave energy approaching the coastline.

### 6.7.4 Geology

The predominant bedrock types within Liverpool Bay and more specifically the physical processes study area is comprised of Permo-Triassic and Carboniferous sandstone, mudstone and limestone. This bedrock is covered by Quaternary sediments that have a thickness exceeding 50 m in the eastern and western Irish Sea (Mellett *et al*., 2015).

Properties of the Quaternary sediments are known to be highly variable both laterally and with depth due to repeated fluctuations of ice sheets during the last glacial period (Mellett *et al*., 2015). It has also been evidenced that the uppermost surface of bedrock that is found beneath the Quaternary sediment has potentially been weathered due to the last glacial period, therefore it could be weaker than the underlying rock (Mellett *et al*., 2015).

### 6.7.5 Hydrography

The UK Hydrographic Office states that the mean tidal range at the Standard Port of Holyhead is approximately 3.65 m whilst at Douglas it is 4.55 m. However, it was the Standard Port of Llandudno which was utilised for calibration of the numerical models used to support this assessment given its proximity to the physical processes study area, which has an average tidal range of 5.40 m as published by Admiralty.

Semi-diurnal tides are the dominant physical process in the Irish Sea coming from the Atlantic Ocean through both the North Channel and St Georges Channel. The tidal range in the Irish Sea is highly variable with a range greater than 10 m on the largest spring tides, second largest in Britain.

At spring tides, tidal currents within the physical processes study area are relatively high, with current speeds typically between 0.80 m/s and 0.90 m/s at flood and 0.60 m/s and 0.70 m/s at ebb (Figure 6.5 and Figure 6.6 respectively). Littoral currents are driven by tides, waves, and meteorological events. The littoral currents were modelled during a 1in1 year storm event from the westerly sector, resulting in the increase of currents on the peak flood tide and decreases on the ebb. Further information including tidal flow fields for the east Irish Sea are presented in volume 3, appendix H. Table 6.7 shows the tidal levels at standard ports in Holyhead and Douglas (UKHO, 2023). Principal hydrometric resources used for calibration include Acoustic Doppler Current Profiler (ADCP) wave buoy data, Admiralty tidal harmonics, British Oceanographic Data Centre (BODC) (BODC, 2023), and Coastal Channel Observatory (CCO).

**Table 6.7: Tidal Levels at Standard Ports (UKHO, 2022)**

| Tidal Level | Holyhead | Douglas |
|---|---|---|
| Lowest Astronomical Tide (LAT) | 0.0 | -0.3 |
| Mean Low Water Springs (MLWS) | 0.7 | 0.8 |
| Mean Low Water Neaps (MLWN) | 2.0 | 2.4 |
| Mean Sea Level (MSL) | 3.3 | 3.8 |
| Mean High Water Neaps (MHWN) | 4.4 | 5.4 |
| Mean High Water Springs (MHWS) | 5.6 | 6.9 |
| Highest Astronomical Tide (HAT): | 6.3 | 7.9 |

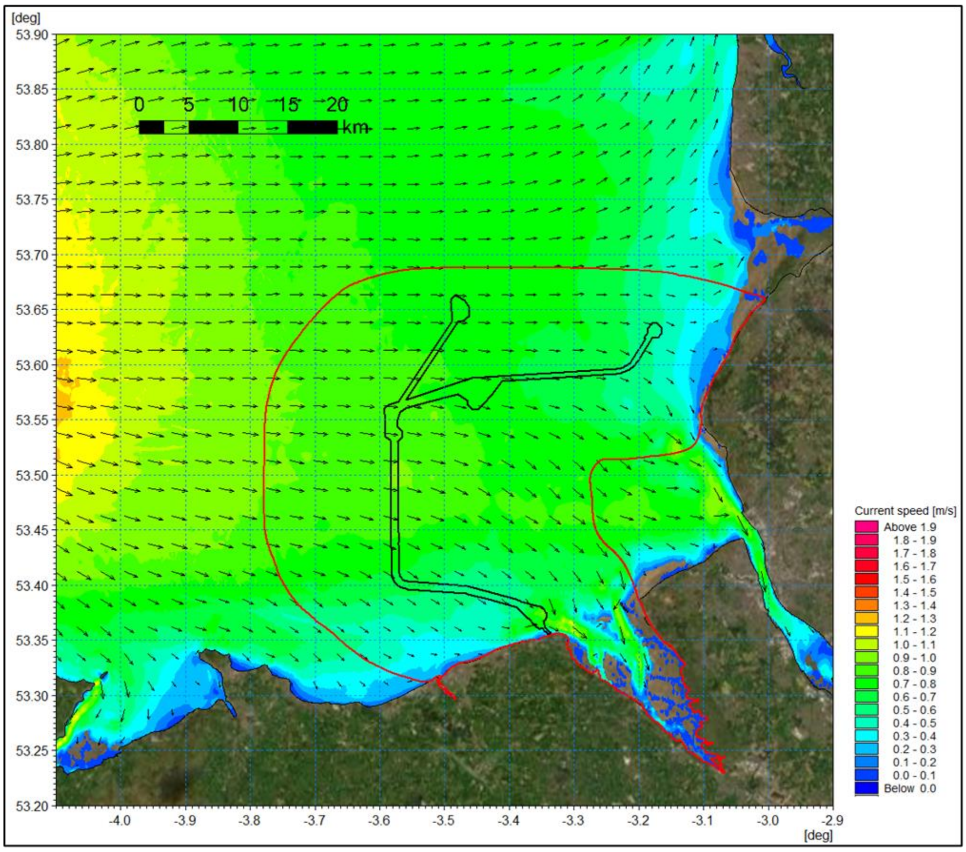


**Figure 6.5: Tidal Flow Patterns – Spring Tide Flood**

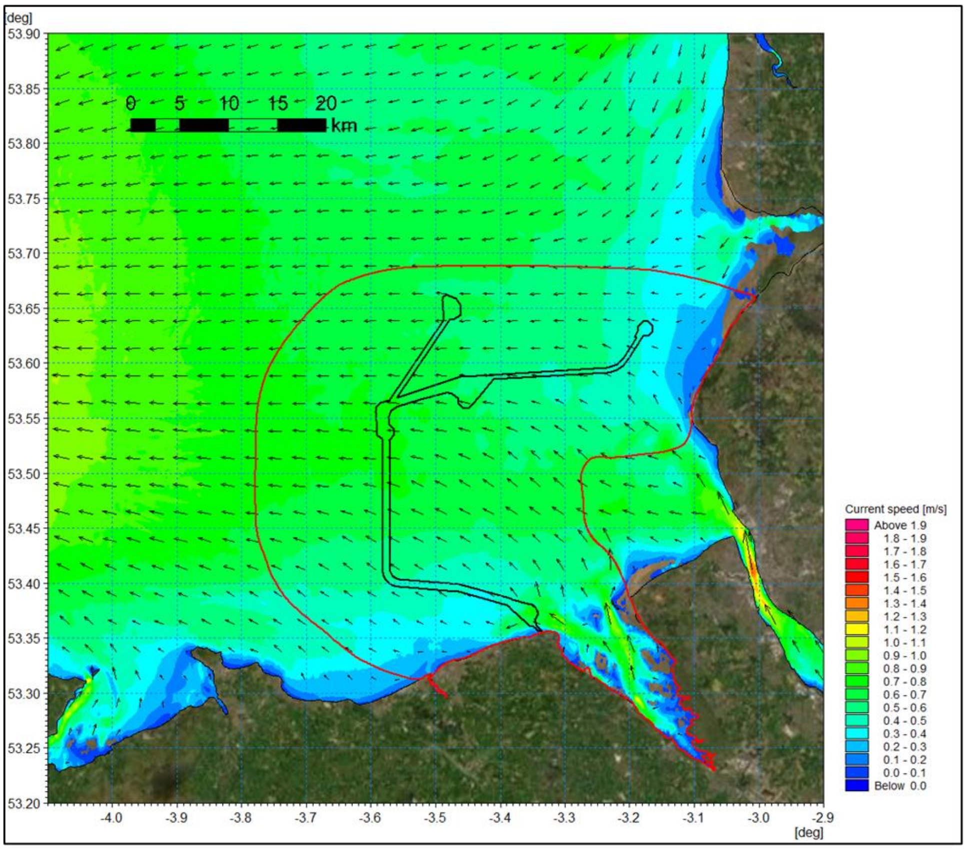


**Figure 6.6: Tidal Flow Patterns – Spring Tide Ebb**

## 6.7.6 Wave climate

Characteristic of the east Irish Sea, waves are generated by either local winds or from remote winds (swell waves). The largest portion of waves entering the physical processes study area do so from the westerly sectors, typically combined wind and swell for the Irish Sea.

The highest mean annual significant wave height of 1.39 m was recorded between the Isle of Man and Anglesey with the significant wave height reducing closer to the coast with a low of 0.73 m recorded within the physical processes study area, to the west of the Dee Estuary (ABPmer, 2023a).

Within the physical processes study area the mean annual wave height ranges from 0.80 m to 1.10 m. Over 40% of waves arise from the west with a majority of significant wave heights (>2 m) coming from this sector also (ABPmer, 2023a).

This directionality corresponds with that seen by winds, with *c*. 40% exhibiting a dominant westerly/south westerly origin. Further detail on the wave climate and meteorological conditions is provided in volume 3, appendix H. Figure 6.7 shows the rose plot for the significant wave height for the physical processes study area, whilst Figure 6.8 shows wind speed and direction. Figure 6.9 and Figure 6.10 show the significant wave heights for 1in1 year storms from the west and north. The model simulated water levels used boundary data extracted from the RPS storm surge model and applied meteorological conditions from the European Centre for Medium-range Weather Forecasting (ECMWF) operational dataset (ECMWF, 2022).

In addition to boundary wave data, it was necessary to analyse the wind field to include the contribution of local wind seas. For this, a representative point for each of the key directions was identified and utilised from the National Oceanic and Atmospheric Administration (2022) 40-year dataset. The model output data was then compared with measured data obtained from the National Network of Regional Coastal Monitoring Programmes held by the Coastal Channel Observatory (2022).

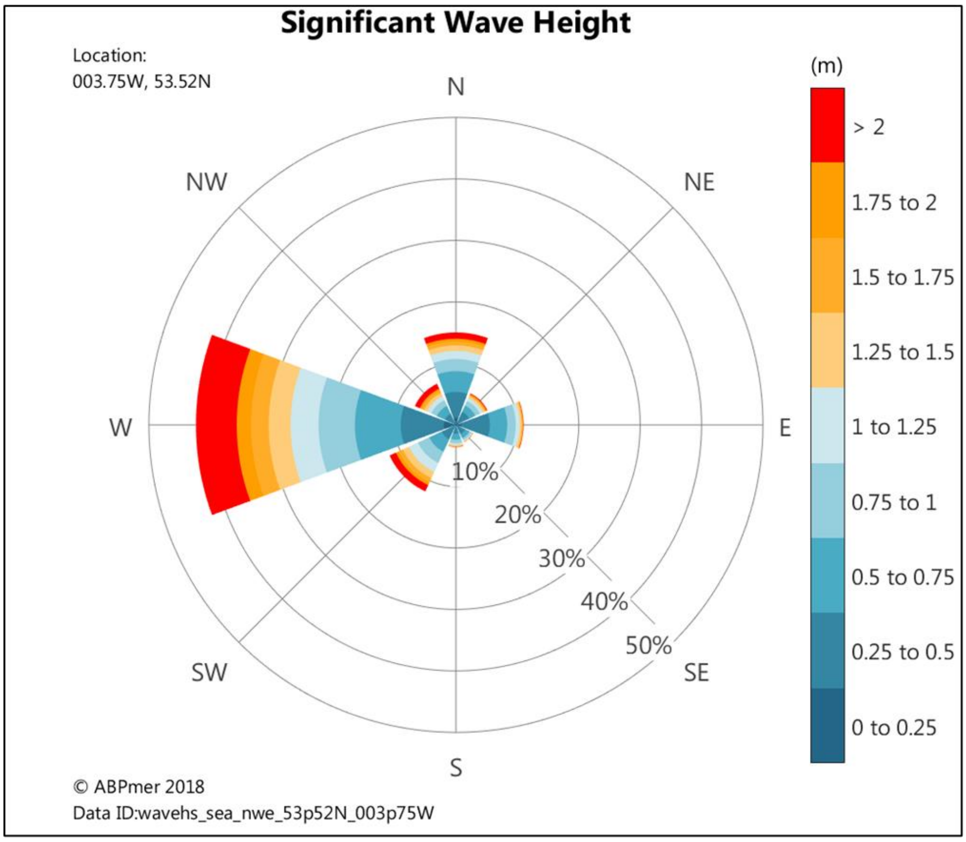


**Figure 6.7: Wave Rose For The Hynet Physical Processes Study Area**

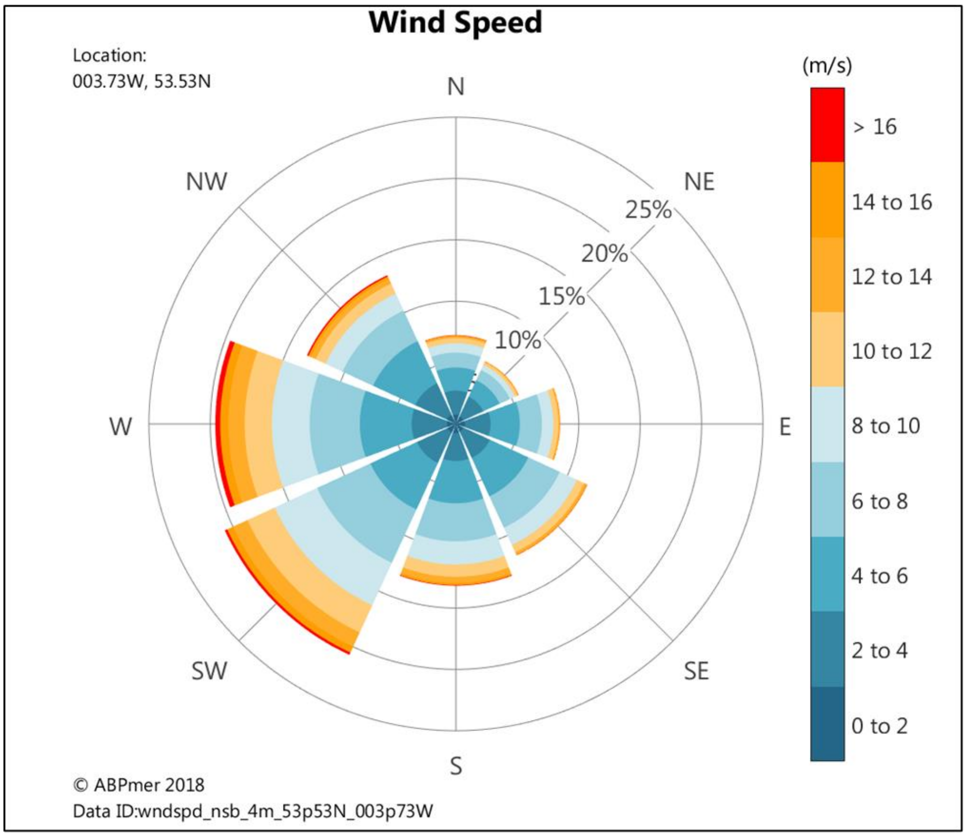


**Figure 6.8: Wind Rose For Hynet Physical Processes Study Area**

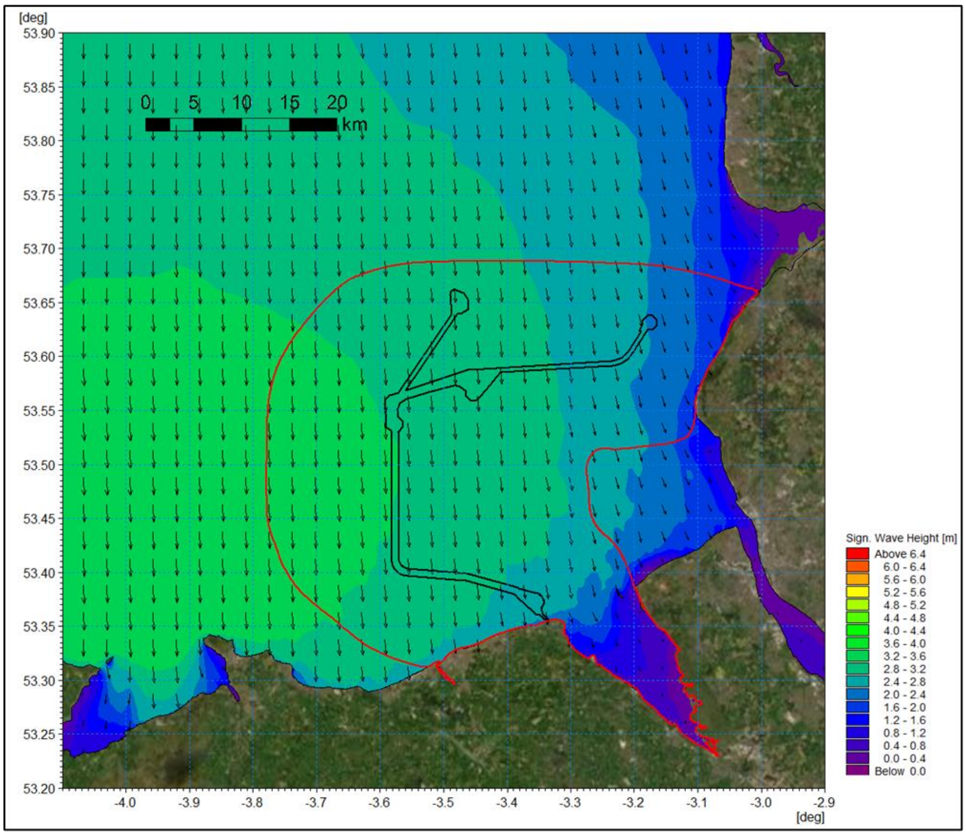


**Figure 6.9: Wave Climate 1:1 Year Storm From 000° MHW**

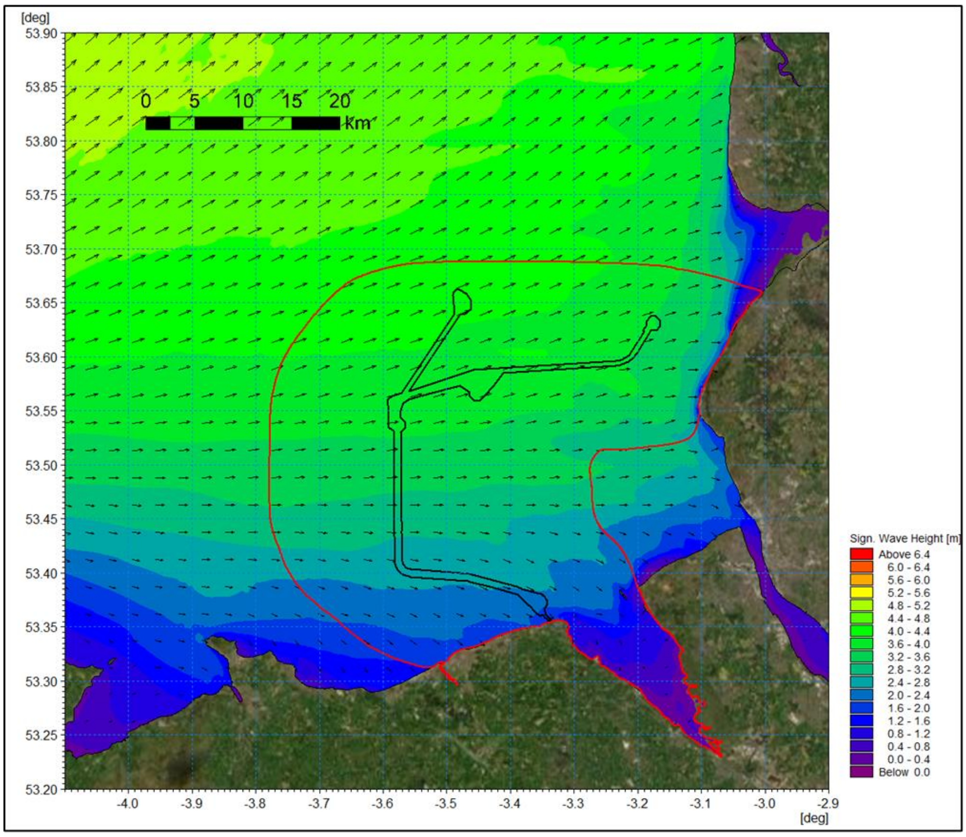


**Figure 6.10: Wave Climate 1:1 Year Storm From 240° MHW**

### 6.7.7 Seabed sediments

To inform the modelling study seabed sediment information was required beyond the extent of survey datasets, and the EMODnet Geology database (EMODnet, 2022) was utilised, as illustrated in Figure 6.11. Across the physical processes study area, the underlying geology consists of bedrock lithologies in the region are Triassic and Carboniferous sandstone and mudstone (Mellett *et al*., 2015). The bedrock of sandstone and mudstone are covered by sediments from the Quaternary age. Potential weathering during the last glacial period may have weakened the uppermost surface of underlying bedrock. Quaternary sediment thickness in the central Irish Sea is <20 m although in short distances this can increase to >100 m due to the presence of glacial valleys. However, in the east and west of the Irish Sea sediment thickness is *c*. 50 m.

In the Irish Sea, there is a high variability in the bedforms ranging from very small ripples (5 cm high) to very large sediment waves (>10 m high). Liverpool Bay itself is characterised by sand ribbons less than 30 cm in height and sand wave fields generally less than 2 m in height between and 10 and 20 m in length. A number of such sand waves can be found with the area of project physical work, with proposed cable route from PoA Terminal to Douglas OP expected to intersect with them. These bedforms can be seen in the detailed bathymetric map of Liverpool Bay presented in Figure 6.3.

In the east and west Irish Sea seabed sediments are subdivided into regions of soft mud (clay and silt) and rich sediment, separated by a central gravel belt containing coarse sand and gravel. A majority of the Liverpool Bay area is composed of circalittoral muddy/ sandy sediment (EMODnet, 2023). More specifically, the seabed sediments found within the Project area are found to be predominantly comprised of circalittoral fine sand, deep circalittoral coarse sediment, and deep circalittoral sand. As the offshore pipeline moves from the offshore development area and the Douglas OP towards the coast of northern Wales, sandy sediments grade into circalittoral muddy sand, circalittoral coarse sediment and circalittoral coarse rock.

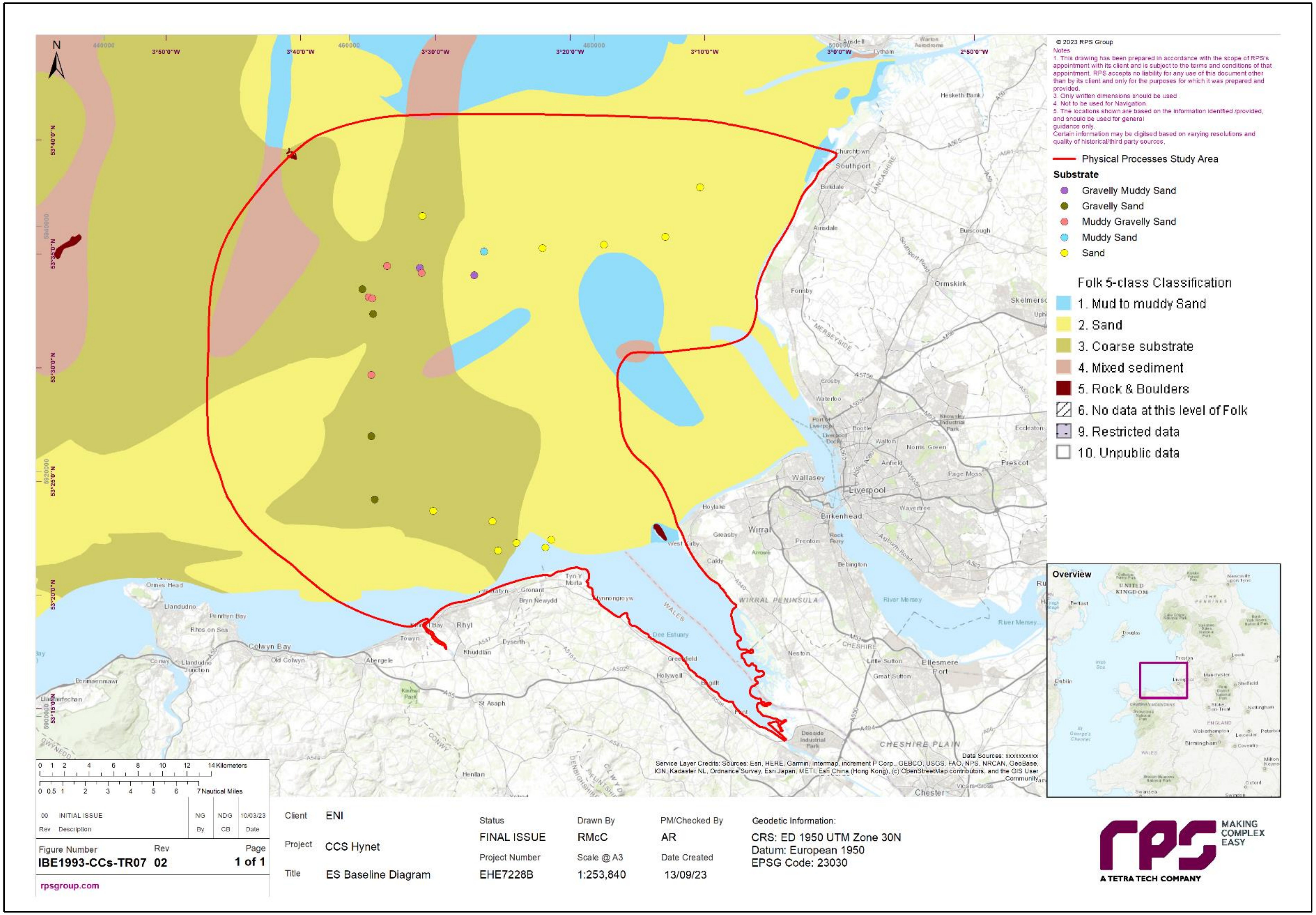


**Figure 6.11: Seabed Substrate Geology Comprised Of Site Specific Grab Samples And EMODnet**

### 6.7.8 Sediment quality and contamination

Within the Irish Sea, sediment contamination levels are typically higher than those in the seawater (Cefas, 2005). The distribution of sediment contaminants is generally similar to that of surface waters. In coastal areas, sediment contamination can occur through anthropogenic run-off into rivers, sewage effluent, or industrial discharge (RWE Renewables, 2021). It can also occur due to contamination and pollution from offshore industries, such as oil and gas activity and shipping, which have historically been substantial in Liverpool Bay.

Sediment type is an important factor to consider when considering contamination levels. For example, those with a finer particle size (such as clays and muds) can adsorb contaminants that are released into the water column during sediment disturbance (Cefas, 2001). Inversely, sediments with larger particle sizes (such as sands) are not typically associated with elevated anthropogenic contaminant concentrations. As noted in section 6.7.7 above, the sediments within the Eni Development Area have largely been characterised as sand and coarse sediments, and as such, would not be expected to contain elevated anthropogenic contaminant concentrations.

The grab samples collected during the site-specific benthic survey (see Table 6.5) were assessed for various contaminants: heavy and trace metals, Polycyclic Aromatic Hydrocarbons (PAHs), Total Hydrocarbon Content (THC), Polychlorinated Biphenyls (PCBs), and organotins. These were compared to national and international reference levels (e.g. Cefas Action Level 1 (AL1), Oslo Paris Convention (OSPAR) levels, etc.), where relevant. The results are summarised below and presented in full in volume 3, appendix I1.

#### 6.7.8.1 Metals

Concentrations of metals in sediments are typically higher in the coastal zone and estuaries but decrease offshore. This indicates that riverine input and run-off from land are significant contamination sources. The site-specific survey tested for a total of eight heavy and trace metals: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni) and (Zn). The results of the site-specific survey indicated that the Cefas AL1 was exceeded for As and Cd at one sampling station each, but not for any of the other metals assessed. Both the sampling stations where As and Cd exceeded Cefas AL1 were in areas surrounding oil and gas infrastructure that is proposed to be partially decommissioned. Hg was above the OSPAR level in seven sampling stations but did not exceed Cefas AL1. Zn was the most abundant metal recorded but was always measured below reference levels at all sampling stations.

Overall, all metals occurred in concentrations comparable to existing background data or in line with the range of concentrations expected for areas located in the proximity of active oil and gas platforms.

#### 6.7.8.2 Polycyclic Aromatic Hydrocarbons

PAHs are a group of structurally related hydrocarbons. Generally, they are not released into the environment intentionally but are naturally present in fossil fuels and other hydrocarbon-based materials associated with development (RWE Renewables, 2021). PAHs persist in the environment and have the potential to bioaccumulate with consequential adverse effects on aquatic and human life (Environment Agency, 2019).

The results of the site-specific survey indicated that Cefas AL1 was only exceeded at one sampling station for both Chrysene and Benzo[a]pyrene. The OSPAR reference levels were exceeded at six sampling stations for Naphthalene, four for Pyrene and Benzo[a]anthracene, three for Anthracene, and one for Benzo[k]fluoranthene and Benzo[a]pyrene. The most abundant PAH recorded was Benzo[b]fluoranthene.

A positive correlation was observed between chrysene, Benzo[a]pyrene and mud content, with higher PAHs concentrations in muddier sediments; this aligns with expectations, due to the higher likelihood of contaminants adsorbing onto sediment fines (i.e. the mud and clay components). No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings.

#### 6.7.8.3 Total Hydrocarbon Concentrations

THC is used to describe the quantity of measured hydrocarbon impurities present in the sediment samples. The THC in sediment samples collected during the site-specific survey ranged from 1,320 µg/kg to 30,600 µg/kg. In the North Sea, THC concentrations at locations between 1 to 2 km from an active platform range between 32,710 µg/kg to 33,810 µg/kg, in line with the maximum value recorded, which was located in the proximity of a platform.

#### 6.7.8.4 PCBs

PCBs are man-made chemical compounds that were banned in the mid-1980s due to concerns about their toxicity, persistence, and potential to bioaccumulate in the environment. They do not break down easily and are extremely toxic to marine and human life (OSPAR, 2023).

The site-specific survey tested for seven PCB congeners (PCB28, PCB52, PCB101, PCB118, PCB138, PCB153 and PCB180, described as the International Council for Exploration of the Seas (ICES) Seven), which are widely used in environmental monitoring as they cover the range of toxicological properties of the group. Most PCBs had concentrations below the detection limit of 0.08 µg/kg across the survey area. No Cefas Action Levels exist for each individual PCB, but for the sum of the seven PCBs (ΣICES7), the AL1 is 10 µg/kg.

PCB138 had the highest concentrations, ranging from below the limit of detection at 39 sampling stations, to a maximum of 0.41 µg/kg. ΣICES7 was below Cefas AL1 at all sampling stations.

#### 6.7.8.5 Organotins

Organotins (dibutyltin and tributyltin) have been used as biocides, polymer stabilisers, preservatives, and catalysts in various industrial processes. They typically enter the marine environment through antifouling paint on vessels and infrastructure, and via wastewater and sewage sludge discharged from water treatment facilities (Diez *et al.,* 2002). Both dibutyltin and tributyltin were below the limit of detection at all sampling stations.

#### 6.7.8.6 Bacterial contaminants

Suspended sediments can also transport biotic contaminants, such as *Escherichia coli* bacteria (Jamieson *et al.,* 2005; Russo *et al.,* 2011; Bradshaw *et al.,* 2021). There are classified shellfish waters present within Liverpool Bay, which are regularly monitored by Cefas for *E. coli* contamination. *E. coli* levels are used as an indicator for microbiological contamination in shellfish, as this bacterium is present in animal and human faeces in large numbers. It can, therefore, indicate contamination of faecal origin, and that other harmful faecal bacteria may be present. *E. coli* levels in common cockle *Cerastoderma edule* have been regularly monitored at four locations in the mouth of the Dee Estuary since 2013 (Cefas, 2023). There are currently 383 samples available, which range from <18 *E.coli* per 100 g (minimum threshold) to 35,000 *E. coli* per 100 g (Cefas, 2023). The average contamination value is 462 *E. coli* per 100 g (standard deviation ± 1,917), and the median value is 140 *E. coli* per 100 g (Cefas, 2023). These median and average *E. coli* contamination levels fall under Class A and Class B, respectively, with Class A suitable for harvesting for direct human consumption and Class B requiring purification processes before being suitable for human consumption (Cefas, 2023).

### 6.7.9 Sediment transport

Residual currents are the net flow over a full tidal cycle and drive the sediment transport. Residual current flow into the east Irish Sea from the north of the Isle of Man and west around Anglesey correlates with this region being a sediment sink (Figure 6.12). The greatest residual current speeds within the physical processes study area occur along headlands and within the Dee Estuary where finer sand fractions are present and where tidal currents are strongest, corresponding with the largest rates of sediment transport which too occur within the Dee Estuary.

Sediment transport rates are greatest during spring tides and specifically the dominant flood tide, with total sediments loads of up to 0.001 $m^3/s/m$, and 0.0005 $m^3/s/m$ on the ebb of the spring tide. Net sediment transport rates are generally <2.00 $m^3/d/m$ across the physical processes study area, however, can reach as high as 200 $m^3/d/m$ in localised areas, such as within the Dee Estuary. The mechanism is more clearly illustrated in Figure 6.13 and Figure 6.14 for flood and ebb tides respectively. It is evident that transport rates are highest during the dominant flood tide and the region is a sediment sink.

The coastline of Liverpool Bay is for the most part experiencing gradual erosion and coastal retreat, the greatest of which occurs on the coastline of the sediment subcell Formby Dunes (Halcrow Group Limited, 2010). Localised areas defended by seawalls experience little to no retreat, however naturally defended shorelines and those defended by revetments are expected to experience drawback.

The physical processes study area coincides with the Solway Firth sediment cell and sub-cell 11a Great Orme's Head to Southport Pier. In the sub-cell 11a the general direction of sediment transport is west to east. This direction of travel supplies the southeast shoreline with sediment (Price *et al.,* 2010).

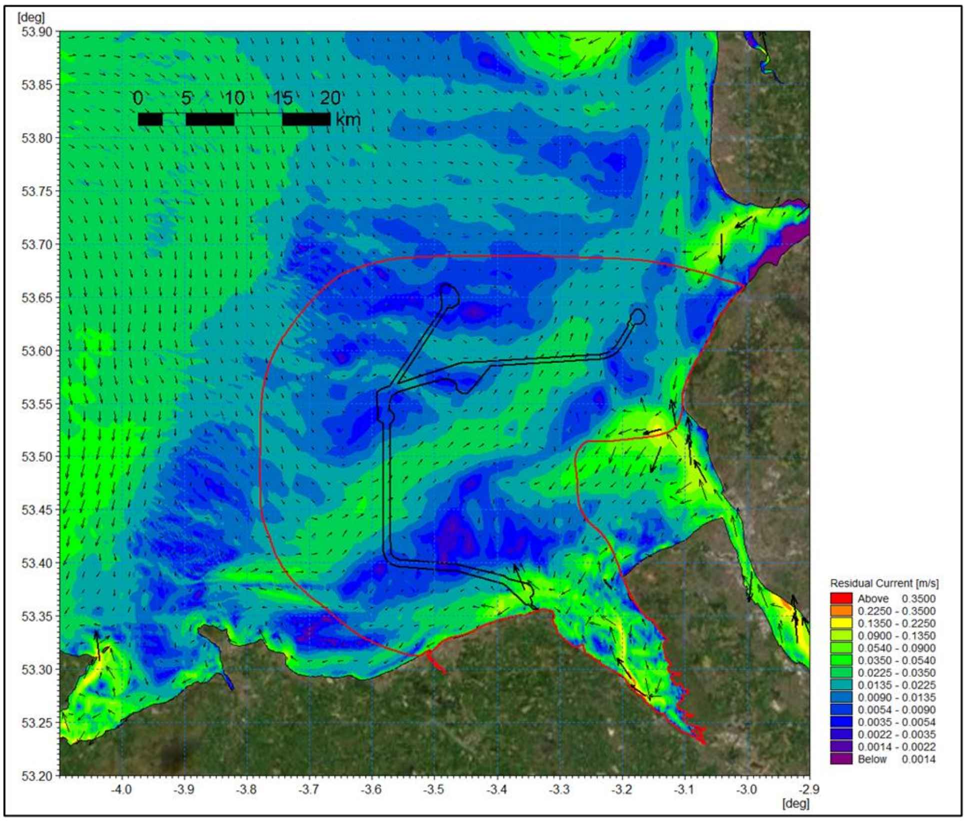


**Figure 6.12: Residual Current Spring Tide**

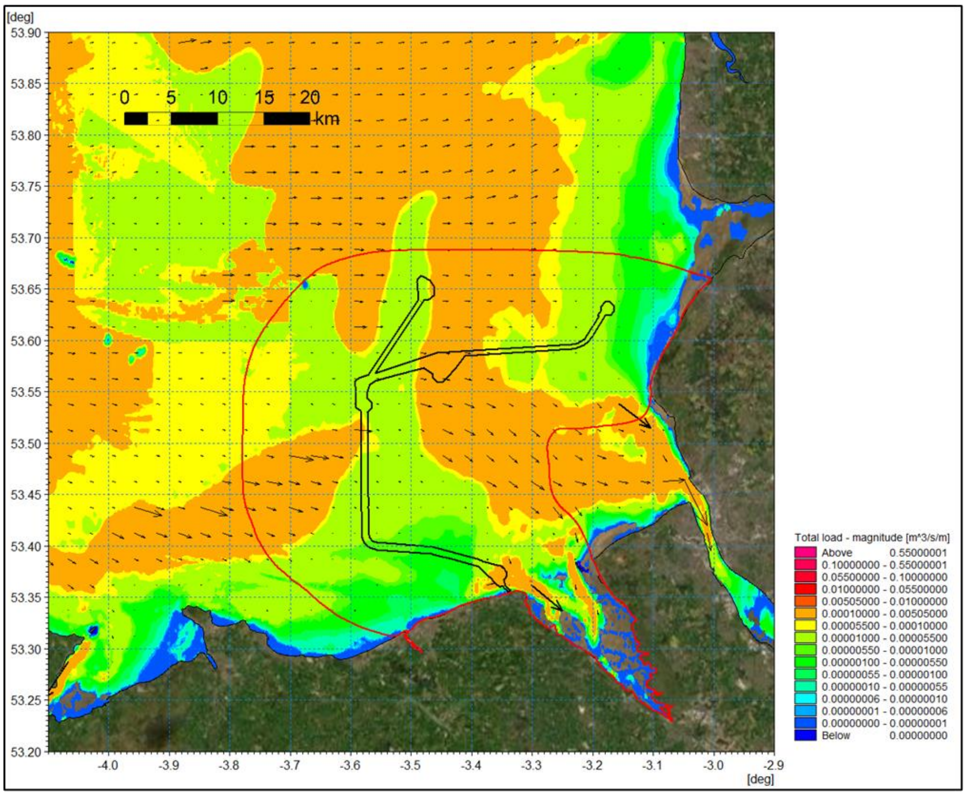


**Figure 6.13: Sediment Transport – Flood Tide**

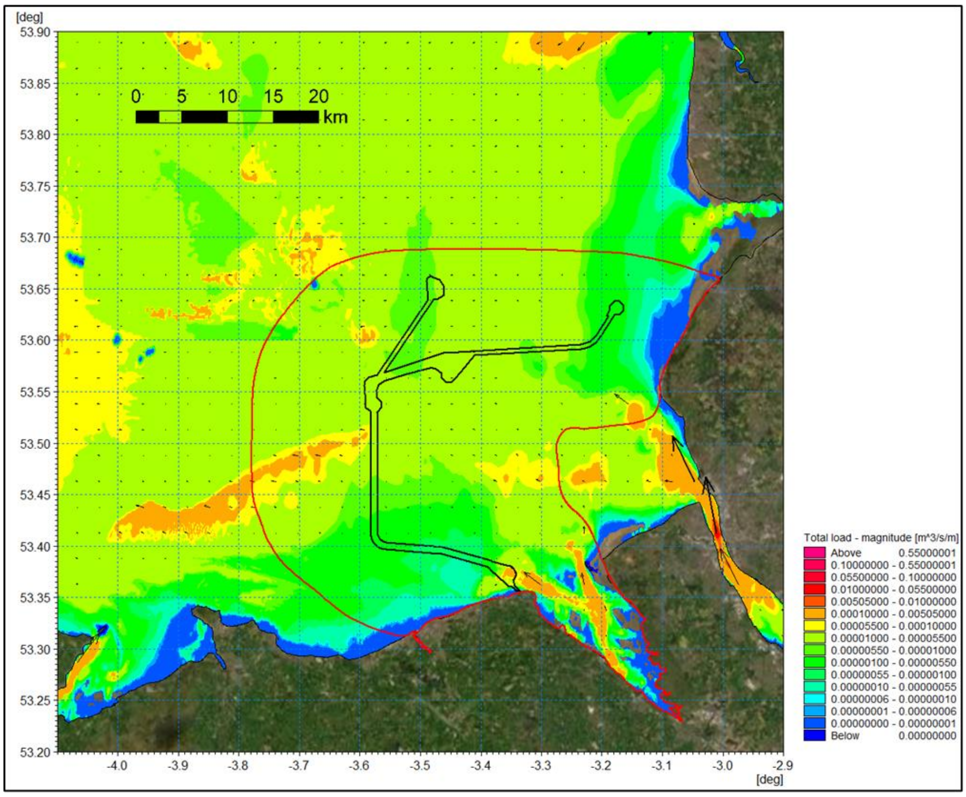


**Figure 6.14: Sediment Transport – Ebb Tide**

### 6.7.10 Suspended sediments

CEFAS Climatology Report 2016 (CEFAS, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the UK Continental Shelf (UKCS), the distribution of which is shown for Liverpool Bay in Figure 6.15. SSC are regulated by tidal currents and intensify during wind-driven storm events throughout the water column. SSC levels have a seasonal pattern due to the seasonality of storm events. Mean annual SSC values along the coastline can be in excess of 30 mg/l in areas such as Liverpool Bay due to the discharge of large rivers such as The Dee and The Mersey. Thus, the more turbid and shallower nearshore development area experiences higher average concentrations than that offshore, with mean concentrations of up to *c*.20 mg/l adjacent to the PoA, and concentrations between 2 mg/l and 10 mg/l further offshore.

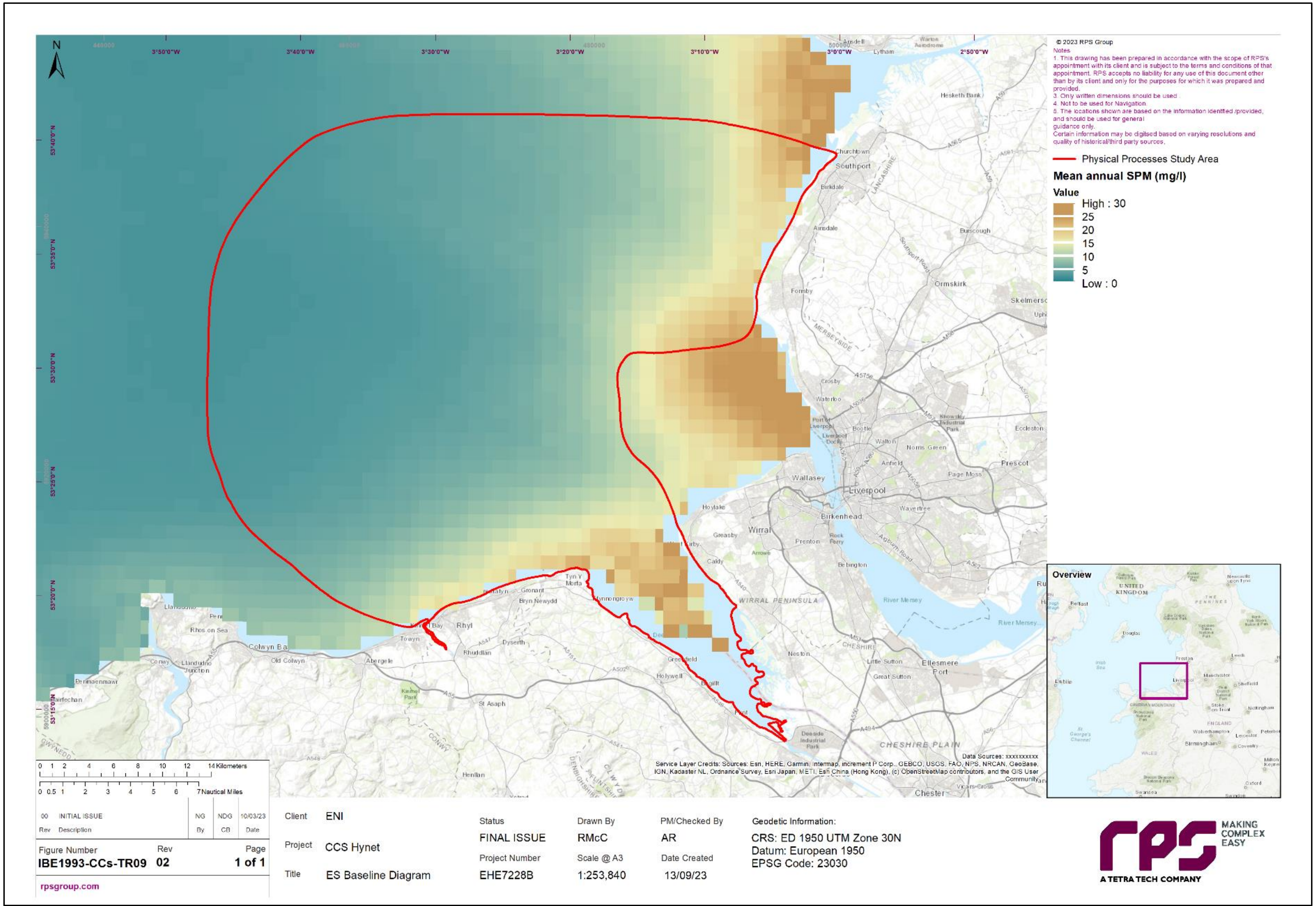


**Figure 6.15: Distribution Of Average Non-Algal Suspended Particulate Matter – CEFAS**

### 6.7.11 Water quality

The concentrations of dissolved contaminants in seawater samples are often low or below detection limits (Cefas, 2005). This is due to the hydrophobic nature of many organic contaminants and the partitioning of metals to suspended particles in the water column (Cefas, 2005). Within the Irish Sea, and more specifically within Liverpool Bay, water quality is predominantly affected by contamination from rivers, sewage effluent, or industrial discharge (RWE Renewables, 2021). Within Liverpool Bay, anthropogenic sources of contamination predominantly originate from rivers, as opposed to direct input (Cefas, 2005).

A range of contaminants can be present in seawater, such as: radioactive isotopes, hydrocarbons, trace metals, and bacteria. Radioactive isotopes are relatively soluble in seawater. Within the eastern Irish Sea, they are dispersed from the Sellafield reprocessing plant (Cumbria), which represents the largest single input of radioactive material in the area (DEFRA, 2005). However, the resulting exposure to radioactive material remains well below levels known to cause adverse effects for marine species (Npower, 2005).

Metal contamination is typically highest within estuarine and coastal waters, which are subject to industrial and wastewater inputs (Cefas, 2005). Liverpool Bay has historically been contaminated with Hg (Ministry of Agriculture, Fisheries and Food (MAFF), 1991), which is attributed to inputs of industrial effluents from the Mersey Estuary. The Irish Sea also receives the largest single input of Pb from the River Mersey (DEFRA, 2005). Elevated Cu level in the Liverpool Bay region (in comparison to the rest of the Irish Sea) are attributed to the River Dee and River Mersey (Marine Pollution Monitoring Management Group (MPMMG), 1998). Discharge from rivers is also a major source of Cd and Zn in the region (Norton *et al.,* 1984).

Liverpool Bay has also historically been the site of oil and gas industry, which can cause water contamination through the discharge of chemicals used for production and drilling and residual oil (Cefas, 2005).

### 6.7.12 Designated sites

Using the Joint Nature Conservation Committee (JNCC, 2023) database (https://jncc.gov.uk/our-work/marine-protected-area-mapper/) Ramsar (2023) and DEFRA databases, designated sites identified for the physical processes study area are described in Table 6.8 and illustrated in Figure 6.16.

**Table 6.8: Designated Sites and Relevant Qualifying Interests for the Physical Processes Chapter.**

| Designated Site | Closest Distance to the Area of Project Physical Work (km) | Relevant Qualifying Interest |
|---|---|---|
| **Marine Conservation Zones (MCZs)** | | |
| Flyde MCZ | 1.80 | Qualifying Features:<br>• Subtidal sands and subtidal muds that are highly productive and evidenced to support an abundance of animals such as crustacean, starfish, and bivalve species including: nut-shell *Nucula nitidosa*, razor shell *Pharus legumen* and the white furrow shell *Abra alba*. Flatfish, including sole *Solea solea* and plaice *Pleuronectes platessa*, in addition to whiting *Merlangius merlangus* are also supported by the habitat within the site. |
| **Special Areas of Conservation (SACs), Ramsar Sites and Special Protection Areas (SPAs)** | | |
| Ribble and Alt Estuaries SPA and Ramsar Site | 6.10 | Qualifying Features:<br>• The site consists of extensive areas of sandflats and mudflats, as well as large areas of |

| Designated Site | Closest Distance to the Area of Project Physical Work (km) | Relevant Qualifying Interest |
|---|---|---|
| | | saltmarsh, particularly in the Ribble. There are also areas of coastal grazing marsh.<br>• The site supports breeding ruff *Philomachus pugnax*, common tern *Sterna hirundo* and lesser black-backed gull *Larus fuscus graellsii*. The site also supports wintering Bewick's swan *Cygnus columbianus bewickii*, whooper swan *Cygnus cygnus*, golden plover *Pluvialis apricaria*, bar-tailed godwit *Limosa lapponica*, pink-footed goose *Anser brachyrhynchus*, shelduck *Tadorna tadorna*, wigeon *Anas penelope*, teal *Anas crecca*, pintail *Anas acuta*, oystercatcher *Haematopus ostralegus*, grey plover *Pluvialis squatarola*, knot *Calidris canutus islandica*, sanderling *Calidris alba*, dunlin *Calidris alpina alpine*, black-tailed godwit *Limosa limosa islandica*, redshank *Tringa tetanus*. The Ribble and Alt Estuaries SPA also supports passage populations of ringed plover *Charadrius hiaticula*, sanderling *Calidris alba*, and redshank *Tringa tetanus*. |
| Mersey Narrows and North Wirral Foreshore SPA and Ramsar Site | 9.0 | Qualifying Features:<br>• The site comprises of intertidal habitats, man-made lagoons, and extensive intertidal flats.<br>• The site supports non-breeding bar-tailed godwit, little gull *Hydrocoloeus minutus*, and knot. The site also supports breeding common tern and an internationally important waterbird assemblage. |
| The Dee Estuary SAC, Ramsar Site and SPA | 0.0 | Qualifying Features:<br>• Mudflats and sandflats not covered by seawater at low tide; Salicornia and other animals colonizing mud and sand; Atlantic Sea meadows *Glauco-Puccinellietalia maritimae*, embryonic shifting dunes, shifting dunes along the shoreline, fixed dunes with herbaceous vegetation and humid dune slacks, and estuaries.<br>• Internationally important populations include oystercatcher, knot, curlew *Numenius arquata*, redshank, bar-tailed godwit, black-tailed godwit, grey plover and dunlin. |
| **Sites of Scientific Interest (SSSI) (DEFRA, 2023)** | | |
| Dee Estuary SSSI | 5.0 | Qualifying Features:<br>• The Dee Estuary is of special interest for its populations of internationally important wintering waterfowl *Anseriformes sp.*, term species, intertidal mud and sandflats, saltmarsh and transitional habitats.<br>• Internationally important populations include oystercatcher, knot, curlew, redshank, bar-tailed godwit, black-tailed godwit, grey plover and dunlin. |
| North Wirral Foreshore SSSI | 8.80 | Qualifying Features:<br>• Intertidal sand and mudflats and embryonic saltmarsh of considerable importance. |

| Designated Site | Closest Distance to the Area of Project Physical Work (km) | Relevant Qualifying Interest |
|---|---|---|
| Ribble Estuary SSSI | 6.80 | Qualifying Features:<br>• Extensive intertidal sand-mud flats and areas of reclaimed saltmarsh, supporting internationally important populations of wildfowl. |
| Sefton Coast SSSI | 6.20 | Qualifying Features:<br>• Intertidal mud, sandflats, embryonic shifting dunes, mobile dunes, dunes creeping with willow *Salix arenaria*, humid dune slacks, fixed dunes, dune grasslands and dune heath.<br>• Assemblages of vascular and non-vascular plants, in particular the nationally rare grey hair grass *Corynephorus canescens*, nationally scarce liverwort *Pentalophyllum ralfsii* and nationally rare moss *Bryum neodamense*. |
| **Bathing Water Locations** | | **Bathing Water Quality Classification** |
| Rhyl | 2.10 | Sufficient |
| Ainsdale | 6.0 | Good |
| West Kirby | 7.60 | Excellent |
| Southport | 6.40 | Good |

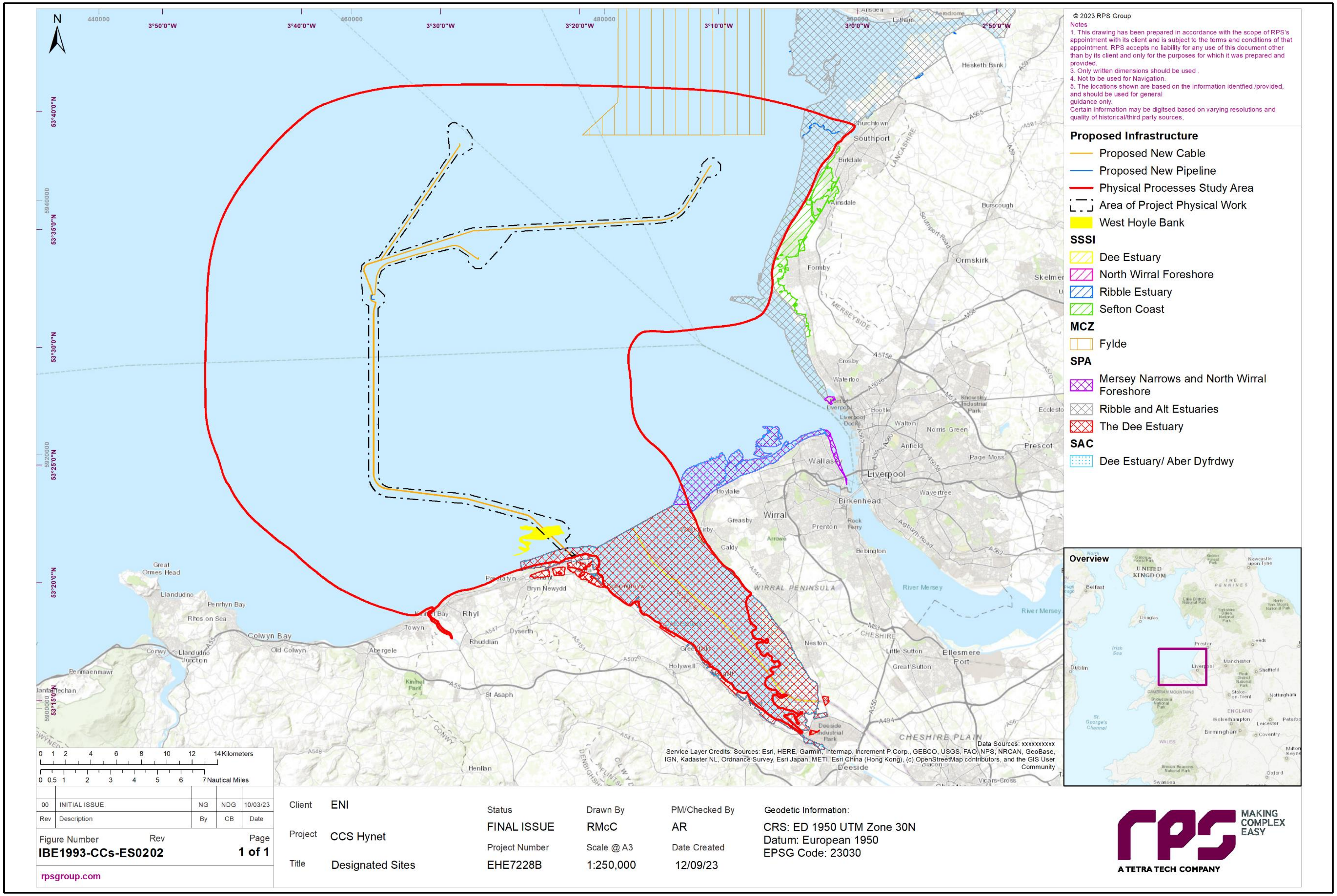


**Figure 6.16: Designated Sites and Relevant Qualifying Interests for the Physical Processes Chapter**

### 6.7.13 Future baseline scenario

The ‘2020 EIA Regulations’, require that a “*a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge*” is included within the ES.

The baseline environment for physical processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the proposed development in place due to natural variability. Future baseline conditions would be altered by climate change resulting in sea level rise and increased storminess. This is unlikely to have the effect of significantly altering tidal patterns and sediment transport regimes offshore in the development area. The return period of the wave climates would be altered (e.g. what is currently defined as a 1 in 50 year event may become a 1 in 20 year event) as deeper water would allow larger waves to develop. Although increased water depth would potentially increase the wave climate, sandbank development is driven by tides and sediment source rather than waves (Kenyon and Cooper, 2005). Therefore, shallow water and drying features, such as West Hoyle Bank would continue to develop. There is, however, a notable degree of uncertainty regarding how future climate change will impact prevailing wave climates within the Irish Sea and beyond.

## 6.8 Key parameters for assessment

### 6.8.1 Maximum design scenario

A range of potential impacts on physical processes have been identified which could potentially occur during the construction, operation and maintenance, and decommissioning phases of the Proposed Development.

Impacts that have been scoped into the assessment are outlined in Table 6.9 along with the identified maximum design scenarios. The maximum design scenarios have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

**Table 6.9: Maximum Design Scenario Considered for Each Impact as Part of the Assessment of Likely Significant Effects on Physical Processes**

| Potential Impact | Phase[a] C | O | D | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| Increased suspended sediment concentrations (SSCs) and sediment deposition | ✓ | ✓ | ✓ | **Construction phase**<br>Seabed preparation<br>Sand wave clearance:<br>• South of Douglas OP: sand wave clearance to occur through the use of max flow excavator. Channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m. Total spoil volume of 3,450 $m^3$. Sand wave clearance activities undertaken over an approximate duration of 3 days.<br>Dredging:<br>• West Hoyle Bank: Dredged channel to be excavated with a length of 1 km, width of 21 m and height of 7 m, through the use of backhoe dredger. Total spoil volume of 147,000 $m^3$. Dredging activities to be undertaken over approximate duration of 2 weeks.<br>Cable installation<br>• PoA Terminal to Douglas OP: Installation via trenching of two separate cable lengths of *c*.33,990 m, with trenches spaced *c*.30 m apart. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of c.153,000 $m^3$ per cable.<br>Inter-OP cables:<br>• Doulas to Lennox: Installation via trenching of *c*.32.34 km of cabling. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 145,530 $m^3$.<br>• Douglas to Hamilton North: Installation via trenching of *c*.14.89 km of cabling. Trench width of up to 3 m and a | **Construction (also applies to decommissioning phase)**<br>• There is potential for increased SSCs and deposition associated with various forms of seabed preparation activities (jetting, ploughing, mechanical cutting, drilling) and cable installation activities. Therefore, smaller particles located within the sediment could potentially be raised into suspension during the construction phase of the Proposed Development.<br>**Operation and maintenance phase**<br>• There is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during cable installation during the construction phase of the Proposed Development.<br>**Decommissioning phase**<br>• There is potential for increased SSCs and deposition associated with the removal of the Proposed Developments infrastructure/equipment. In a worst-case scenario, the effects are likely to be similar to those exhibited during the construction phase. |

| Potential Impact | Phase[a] | | | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | C | O | D | | |
| | | | | • depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 67,005 $m^3$.<br>• Douglas to Hamilton: Installation via trenching of *c*.10.87 km of cabling. Trench width of up to 3 m and a depth of up to 3 m. Trenching rate of 450 m/h. Total spoil volume of 48,915 $m^3$.<br>Drill cuttings dispersion<br>• Monitoring wells: Two drilled monitoring wells at Hamilton and Hamilton North. 26" section drilled over a vertical distance of 118.90 m. 17" section drilled over a vertical distance of 518.16 m. 100% hole washout assumed to account for released drilling muds. Total spoil volume of 340.08 $m^3$ per monitoring well.<br>**Operation and maintenance phase**<br>• PoA Terminal to Douglas OP: The repair/ replacement and/or reburial of damaged or exposed cable sections/ whole cable will may be required over the proposed development lifetime, to occur as required from inspection.<br>• Inter-OP cables: The repair/ replacement and/or reburial of damaged or exposed cable sections/ whole cable will may be required over the proposed development lifetime, to occur as required from inspection.<br>**Decommissioning phase**<br>• All injection facilities, cabling and cable protection in the form of cable crossings, associated with the Proposed Development are to be removed at the end of the operation and maintenance phase. | |
| Changes to seabed morphology due to sand wave | ✓ | ✓ | ✓ | **Construction phase**<br>Seabed preparation<br>Sand wave clearance: | **Construction phase**<br>There is potential for seabed preparation activities relating to sand wave clearance activities and the dredged channel through West |

| Potential Impact | Phase[a] | | | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | C | O | D | | |
| clearance and cable protection measures | | | | • South of Douglas OP: sand wave clearance to occur through the use of max flow excavator. Channel cleared through a length of 115 m of sand waves, with a width of 10 m and height of 3 m. Total spoil volume of 3,450 $m^3$. Sand wave clearance activities undertaken over an approximate duration of 3 days.<br>Dredging:<br>• West Hoyle Bank: Dredged channel to be excavated with a length of 1 km, width of 21 m and height of 7 m, through the use of backhoe dredger. Total spoil volume of 147,000 $m^3$. Dredging activities to be undertaken over approximate duration of 2 weeks.<br>**Operation and maintenance phase**<br>Cable protection:<br>• PoA Terminal to Douglas OP: Cable protection in the form of third party cable crossings, to be utilised in up to 10 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m.  Cable crossings to be located between 5.8 m and 30.8 m water depth to CD<br>Inter-OP cables:<br>• Douglas to Lennox: Cable protection in the form of third party cable crossings, to be utilised in up to 6 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located between 25 m and 30 m water depth to CD.<br>• Douglas to Hamilton North: Cable protection in the form of third party cable crossings, to be utilised in up to 8 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located between 25 m and 30 m water depth to CD. | Hoyle Bank to impact upon seabed morphology during the construction phase.<br>During the construction phase there will be gradual changes as infrastructure is introduced into the environment. With changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (MDS) assessed in the following section below.<br>**Operation and maintenance phase**<br>There is potential for the cable protection installed at cable crossings during the construction phase to impact upon seabed morphology during the operation and maintenance phase, along all cable routes.<br>**Decommissioning phase**<br>The decommissioning phase will involve removal of all infrastructure from the seabed in line with the Government's aim to achieve a clear seabed. |

| Potential Impact | Phase[a] | | | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | C | O | D | | |
| | | | | • Douglas to Hamilton: Cable protection in the form of third party cable crossings, to be utilised in up to 8 locations along the cable route, with a height of up to 0.8 m and width of up to 7 m. Cable crossings to be located within 25 m and 30 m depth to CD. | |
| Activities affecting surrounding water quality | ✓ | ✓ | ✓ | **Construction Phase**<br>Increased SSCs, release of sediment bound contaminants and bacteria<br>The MDS is as described for increased suspended sediment concentrations SSCs and sediment deposition, as resuspension of sediments is the most likely to influence water quality through potential release of sediment bound contaminants and bacteria.<br>Construction vessels causing accidental spills and pollution<br>There will be a total of 236 round trips of vessels associated with the construction phase. This includes a total of 219 round trips of vessels associated with installation of the new Douglas platform and wells (return trips are presented as total across construction period). The remaining 17 round trips of vessels will be associated with installation of the cables.<br><br>**Operation and Maintenance Phase**<br>Increased SSCs, release of sediment bound contaminants and bacteria<br>The MDS is as described for increased SSCs and sediment deposition as resuspension of sediments is the most likely to influence water quality through release of sediment bound contaminants and bacteria.<br>Construction vessels causing accidental spills and pollution | **Construction (also applies to decommissioning phase)**<br>• Construction activities conducted near the shoreline (e.g., trenching for the cable route) could impact water quality in proximity to the coastline through increased SSC.<br>• Construction activities could cause toxicity effects through mobilisation of contaminated sediments through sediment disturbance during cable installation which would potentially affect the surrounding water quality through the local tidal regime and wave climate.<br>• Construction vehicles and vessels have the potential to cause accidental spills and pollution within the development area and the surrounding footprint.<br>• Bacterial release from sediments due to the proximity of designated bathing and shellfish waters.<br>**Operation and maintenance phase**<br>• Operation and maintenance activities could cause toxicity effects through mobilisation of contaminated sediments through sediment disturbance during cable repair activities during operation which could potentially affect the surrounding water quality. However, no cable repairs are anticipated, as the cable will be buried, and installed as a single, unjointed length offshore. General inspection works will be carried out, including using high resolution Multibeam Echosounder, and Side Scan Sonar, and drop- |

| Potential Impact | Phase[a] C | O | D | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | | | | There will be a total of 750 vessel round trips over the entire operation and maintenance phase. This encompasses vessels used during routine inspections, geophysical surveys, removal of marine growth, replacement of corrosion protection anodes, replacement of access ladders and boat landings, modification to/replacement of J tubes at platforms, topsides, inter-platform cables/pipelines and PoA terminal to the new Douglas platform cables/pipelines.<br>Changes to water quality due to cable protection measures<br>The MDS is as described for changes to seabed morphology due to sand wave clearance and cable protection measures, during the operation and maintenance phase.<br>**Decommissioning Phase**<br>Increased SSCs, release of sediment bound contaminants and bacteria.<br>The MDS is as described for increased suspended sediment concentrations SSCs and sediment deposition, as resuspension of sediments is the most likely to influence water quality through potential release of sediment bound contaminants and bacteria.<br>Construction vessels causing accidental spills and pollution<br>There will be a total of 128 round trips of vessels associated with the decommissioning phase, with a maximum of 17 vessels on site at any one time. | down camera of the entire cable length cable in one event every two years.<br>• There is potential for the cable protection installed at cable crossings during the construction phase to impact upon seabed morphology and associated water quality during the operation and maintenance phase, along all cable routes. However, it is anticipated that the external cable protection at existing cable crossings is unlikely to require maintenance, as the rock and concrete mattresses are expected to remain in place. Maintenance or repairs are only anticipated should the cable protection be impacted by either fishing activity, or anchor snagging. Any movement of the rock and mattresses from these external interventions would be identified through the annual asset integrity surveys, and the necessary repairs carried out accordingly. These repairs would be carried out within the maximum design envelope described for the cable crossings external protection in Table 3.4.<br>**Decommissioning phase**<br>• Removal of infrastructure in the decommissioning phase could cause toxicity effects through mobilisation of contaminated sediments. In a worst-case scenario, the effects are likely to be similar to those exhibited during the construction phase.<br>• Fewer vessels and vessel trips are predicted during the decommissioning phase when compared to the construction and operation and maintenance phases. Effects are considered to be less than or similar to those during the construction phase. |

[a] C=construction, O=operation and maintenance, D=decommissioning

### 6.8.2 Impacts scoped out of the assessment

On the basis of the baseline environment and the proposed development description outlined in volume 1, chapter 3, three impacts are proposed to be scoped out of the assessment for physical processes. This was either agreed with key stakeholders through consultation as discussed in volume 1, chapter 5, or otherwise, the impact was proposed to be scoped out in the HyNet Carbon Dioxide transportation and Storage Project – Offshore Scoping Report (RPS, 2022a) and no concerns were raised by key consultees. These impacts are outlined, together with a justification for scoping it out, in Table 6.10.

**Table 6.10: Impacts Scoped Out of the Assessment for Physical Processes (Tick Confirms the impact is Scoped Out)**

| Potential Impact | Phase[a] | | | Justification |
|---|---|---|---|---|
| | C | O | D | |
| Presence of infrastructure may lead to changes in the local tidal regime, wave climate, and sediment transport | ✓ | ✓ | ✓ | • The proposed platform at Douglas consists of four legs *c.*2 m in diameter at a spacing of 17 m. Given the diminutive nature of this structure compared to neighbouring wind turbine structures for which published information is available, the impacts on physical processes would be negligible.<br>• The presence of infrastructure potentially leading to changes in the local tidal regime, wave climate, and sediment transport can therefore be scoped out of the assessment based on these preliminary design parameters and scale of infrastructure proposed. No permanent infrastructure is placed on the seafloor within the intertidal zone. The new electrical cables will be buried to a target depth of 2-3m.<br>• The decision to scope the potential impact pathway out can be supported by the fact that the resultant impact on physical processes such as the sediment transport regime has been included in the assessment of changes to seabed morphology due to sand wave clearance and cable protection measures. |
| Changes to seabed morphology and water quality due to the utilisation of jack-up vessels | ✓ | ✓ | ✓ | • The utilisation of jack-up vessels during the construction and decommissioning phases within the Project area will only be temporary and any potential disturbances on the subsea surface, potentially increasing SSCs and/or causing toxicity effects through the mobilisation of contaminated sediments would likely infill over time and be brief. Therefore, it is not expected that jack-up vessels would have any implications on the surrounding seabed morphology or water quality and this impact is to be scoped out of the physical processes assessment. |

[a] C=construction, O=operation and maintenance, D=decommissioning

## 6.9 Methodology for assessment of effects

The physical processes impact assessment has followed the methodology set out in volume 1, chapter 5. Specific to the physical processes impact assessment, the following guidance documents have also been considered.

- Guidelines in the use of metocean data through the lifecycle of a marine renewable's development (Cooper *et al.*, 2008).
- Physical processes guidance to inform EIA baseline survey, monitoring and numerical modelling requirements for major development projects with respect to marine, coastal and estuarine environments (Natural Resources Wales, Marine Programming and Delivery Group, 2020).
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA or Major Development Projects (Brooks *et al.,* 2018).

- Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects, Department of Communications, Climate Action and Environment (Barnes, 2017).
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2, Department of the Environment, Climate and Communications (Department of the Environment, 2018).
- Collaborative Offshore Wind Energy Research into the Environment – Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment (Lambkin *et al.,* 2009).
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments (Pye *et al.,* 2017).
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects (NRW, 2018)

Physical processes are not generally receptors in themselves; they may be a pathway by which coastal features may be impacted or form a pathway for indirect impacts on other receptors (NRW, 2018). In this context the term 'coastal features' is used to describe any morphological feature within the physical processes study area. By determining any changes in sediment transport to understand the impact upon coastal features, by default, requires the modelling of other physical processes such as tidal current and wave climate. For example, increases in suspended sediments during the construction phase may lead to the deposit of these sediments and smothering of benthic habitats. For this impact, the magnitude of the potential changes has been assessed, with the sensitivity of the receptors to these changes and the significance of effects assessed within volume 2, chapter 7.

The criteria for determining the significance of effects is a two-stage process that involves defining the magnitude of the impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 5.

The criteria for defining the magnitude of impact for physical processes are outlined in Table 6.11 below.

**Table 6.11: Definition of Terms Relating to the Magnitude of an Impact**

| Magnitude of impact | Definition |
|---|---|
| High | Change in physical processes which results in the loss of a coastal feature (e.g. reduction in tidal flows altering sediment loads to coastal sand banks (Adverse)). |
| | Change in physical processes which results in the creation of a coastal feature (e.g. increase in tidal flows altering sediment loads to coastal sand banks (Beneficial)). |
| Medium | Alteration of physical processes which effects the rate at which a coastal feature is maintained (e.g. reduction in bed load transport within the sediment transport regime, which is detrimental to the development of sand waves (Adverse)). |
| | Alteration of physical processes which effects the rate at which a coastal feature is developing (e.g. increase in bed load transport within the sediment transport regime, which supports the development of sand waves (Beneficial)). |
| Low | Variation in physical processes which maintains the coastal feature (e.g. localised change in sediment pathway which does not destabilise bank). |
| Negligible | Imperceptible variation in physical process (e.g. in the order of natural variability). |
| No change | No loss or alteration of characteristics, features or elements; no observable impact either adverse or beneficial. |

The criteria for defining sensitivity of the receptor are outlined in Table 6.12 below.

**Table 6.12: Definition of Terms Relating to the Sensitivity of the Receptor**

| Sensitivity | Definition |
|---|---|
| Very High | Coastal feature or physical process forms vital part of a wider scale system which is scarce and non-recoverable. |
| High | Coastal feature or physical process forms part of a wider scale system and is non-recoverable. |
| Medium | Coastal feature or physical process has limited potential for re-creation. |
| Low | Coastal features or physical processes of local scale and recoverable. |
| Negligible | Coastal feature or physical process adaptable to changes in physical processes. |

The significance of an effect on physical processes is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 6.13. Where a range of significance of effect is presented in Table 6.13, the final assessment for each effect is based upon expert judgement.

For the purposes of this assessment, any effects with a significance level of **minor** or less have been concluded to be not significant in terms of the 'EIA Regulations'.

**Table 6.13: Matrix Used for the Assessment of the Significance of the Effect**

| Sensitivity of receptor | Magnitude of Impact | | | | |
|---|---|---|---|---|---|
| | No Change | Negligible | Low | Medium | High |
| Negligible | No change | Negligible | Negligible or Minor | Negligible or Minor | Minor |
| Low | No change | Negligible or Minor | Negligible or Minor | Minor | Minor or Moderate |
| Medium | No change | Negligible or Minor | Minor | Moderate | Moderate or Major |
| High | No change | Minor | Minor or Moderate | Moderate or Major | Major |
| Very High | No change | Minor | Moderate or Major | Major | Major |

## 6.10 Embedded mitigation

As part of the project design process, a number of mitigation measures have been proposed to reduce the potential for impacts on Physical Processes (see Table 6.14). As there is a commitment to implementing these measures, they are considered inherently part of the design of the proposed development and have therefore been considered in the assessment presented in section 0 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

**Table 6.14: Mitigation Measures Adopted as Part of the Proposed Development**

| Mitigation Measures Adopted as Part of the Proposed Development | Justification |
|---|---|
| Development and adherence to a Cable Specification and Installation Plan which will include cable burial where possible and cable protection. To minimise potential impact from the cables and removal of cables a commitment to bury cables where possible has been made in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021). | The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment (CBRA) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. There is a potential for cable exposure to occur due to interactions between Metocean regime (wave, sand and currents). The sediment transport can lead to exposure of cables and infrastructure, the use of a cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure |
| Scour protection limited to use as third-party cable crossings and monitored in line with Cable Specification and Installation Plan. | To reduce the potential for scouring of seabed sediments to occur. Limited in use in order to reduce interactions between the metocean regime (wave, sand and currents) and seabed structures. |
| No external cable protection in the intertidal area | To minimise potential impacts on intertidal habitats within the Dee Estuary SAC and SPA. |
| Cable protection to have a profiled cross section and height mitigated to < 1 m. | To minimise changes to seabed morphology and physical processes such as tidal current, wave regime and sediment transport pathways, particularly if located in shallow water. |
| Material arising from drilling and/or sand waves and wave clearance will be deposited in close proximity to the works | To retain material within sediment cell, reduce changes to seabed morphology and maintain sediment transport regimes. |
| The Horizontal Directional Drilling (HDD) exit pit will be 3 m below beach level (just above the MHWS line). | HDD exit pit will be located above MHWS at approximately 3m below current beach level, and due to this depth, will not require any external protection. |
| Development of and adherence to an Environmental Management Plan (EMP) that will be prepared and implemented during the construction, operational and maintenance and decommissioning phases of the proposed development. The EMP will include appendices detailing actions to minimise INNS (the INNSMP), and a MPCP will be developed which will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details | Measures will be adopted to ensure that the potential for release of pollutants from construction, operational and maintenance and decommissioning plant is minimised. These will likely include: designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels will be required to comply with the standards set out in the International Convention for the Prevention of Pollution from Ships (MARPOL). |
| Suitable implementation and monitoring of cable protection | Minimises the risk of underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment, as well as monitoring any secondary scour which may occur over time. |

## 6.11 Assessment of significance

The ES considered the potential impacts of the construction, operation and maintenance, and decommissioning phases of the Proposed Development within the physical processes study area and followed the methodology outlined in volume 1, chapter 5. The numerical modelling used to inform the following assessment is found in volume 3, Appendix H.

A description of the potential effect on physical processes receptors caused by each identified impact is given below.

### 6.11.1 Increased suspended sediment concentrations and sediment deposition

There is potential for increased SSC and deposition associated with various forms of seabed preparation activities (jetting, ploughing, mechanical cutting, drilling) and cable installation activities. The following scenarios were modelled to provide quantitative information for assessment of all activities:

- Site preparation activities – sand wave clearance to facilitate cable installation.
- Drill cuttings – associated release of two monitoring well drilling events.
- PoA Terminal to Douglas OP Cable – associated release of one cable representing maximum installation scenario.
- Inter-OP Cables – largest Inter-OP cable installation event modelled (i.e., Douglas to Lennox).

#### 6.11.1.1 Construction phase

**Magnitude of impact**

The preparation of the seabed involves sand wave clearance activities within the area of project physical work which may lead to suspended sediment concentrations and associated deposition. The maximum design scenario for seabed preparation consists of the sand wave clearance of a length of 115 m, with a width of 10 m to an average depth of 3 m, South of Douglas OP. The potential PoA to Douglas cable route may avoid dredging through West Hoyle Bank, instead utilising an existing channel in the bank, however due to the active nature of the bedform this may not be possible. Therefore, the worst case scenario has been assessed which includes a cable route that may require dredging through the Bank, over a length of 1 km, with a width of 21 m and to an average depth of 7 m.

The sand wave clearance South of Douglas OP is anticipated to generate a plume with an average suspended sediment level of 100 mg/l. These levels would be localised and only persist for a short period. Concentrations within the plume envelope are much lower, typically <5 mg/l a short distance from the discharge location. The fine sediment is more widely dispersed, however even peak deposition values that extend beyond the area of project physical work do so at <1 mm. The coarser material settles at the release point itself with average values of <30 mm (*c.*14 mm peak). Some of the finer material associated with the excavation process is re-suspended during successive tides, so that sediment may still be suspended a day after cessation of excavation activities.

A much larger plume is generated by seabed preparation activities at West Hoyle Bank, with average suspended sediments extending close to the mouth of the River Dee, however they do so at concentrations negligible compared to background levels, i.e., <3 mg/l. SSC are greatest along the dredge path and West Hoyle Bank itself, which can be particularly shallow and in some areas dry during low water, under these conditions the average concentrations may be up to 3,000 mg/l. Elsewhere more generally across the area of project physical work SSC values are typically less than 10 mg/l. Deposition is restricted to the physical process study area, with the greatest sedimentation values *c.*3 m occurring adjacent to the dredged channel, this would then form backfill material. Sedimentation one day after the cessation of dredging activity further demonstrates that deposited material is focussed in close proximity to the dredge path, beyond which deposition is generally below <100 mm.

Two drilling events were modelled to simulate releases incurred from the drilling of two new monitoring wells at Hamilton Main and Hamilton North. Both wells are to be drilled with the same parameters with a 26” section drilled over a vertical distance of 118.90 m, and below that a 17” section drilled over a vertical distance of 518.16 m. The materials generated by the 26” section are released at the seafloor and those generated by the 17” section at the sea surface in accordance with the proposed drilling techniques to be implemented. A 100% washout of both monitoring well holes is assumed, this release accounts for the release of fine drilling muds which will create the largest spatial plume i.e. travel furthest. This means well drilling events were modelled with twice the volume of the hole size (with 50% being the drilled sediment and 50% being the drilling mud/fluid).

For both drilling operations maximum SSC and sedimentation values occurred in the direct vicinity of the drill sites. At Hamilton Main peak SSC values experienced at the drill site are limited to *c.*360 mg/l, however peak values are limited in time and extent, average values are typically <30 mg/l. The plume itself extends c.8 km to the east and west. Average deposition across the area can be up to *c*.30 mm at the drill site but is generally less than a tenth of a millimetre across the tidal ellipse. One day after the cessation of drilling, deposition values around the drill site can be in excess of 50 mm however a vast majority of deposition due to released sediment is under 0.03 mm. This is explained by the coarser material remaining at the drill site whilst the finer mud particles are dispersed on successive tides. A similarly sized plume of suspended sediments is produced at Hamilton North, with slightly more northward/southward dispersion. Mean concentrations around the drill site are <30 mg/l and further from the source <0.30 mg/l. Mean sedimentation in direct vicinity to the drill site can reach as high as *c*.60 mm but across the plume is generally <0.10 mm. One day after the cessation of drilling, deposition can be 100 mm in the direct vicinity of the drill site however again quickly decreases to negligible levels with distance from the discharge point.

For the installation of both the PoA Terminal to Douglas OP (33.99 km) and the Douglas to Lennox Inter-OP cable (32.34 km) a trench of up to 3 m in width and 3 m in depth with a triangular cross section may be excavated. The plumes produced by other Inter-OP cables can be assessed using the results of modelling completed for the Douglas to Lennox cable. The Douglas to Hamilton Main Inter-OP cable shares a largely similar cable route as the Douglas to Lennox cable, with a much reduced cable length. The Douglas to Hamilton North cable also features a reduced cable length and reduced residual current speeds, therefore both can be expected to demonstrate similar if not reduced SSC plumes and associated deposition.

The largest plumes are generated by cable installation activities given the magnitude of sediment disturbed and length of works. For the PoA Terminal to Douglas cable, during peak concentrations over the course of trenching, the plume may extend up to 15 km to the west leaving the physical processes study area by *c*.1 km however even at peak values do so at background levels (<1 mg/l). Average SSC values are greatest around the cable route, particular over the shallow waters of West Hoyle Bank, these values may reach 1,000 mg/l in the shallowest water but are quickly reduced to background levels a short distance from the cable path. Average sedimentation is greatest at the location of the trenching and may be up to *c*.160 mm in depth where the coarser material has settled within close proximity to the cable path. An analysis of sedimentation at slack water one day after the cessation of trenching, shows that some of the previously sedimented material has been re-suspended, only to settle again at slack water.

A larger plume again is seen from the trenching of the Douglas to Lennox, which is anticipated to leave the physical processes study area on the western extent, however, again does so at background levels. Average concentrations are <1,000 mg/l and are greatest in the direct vicinity of the cable path, and <10 mg/l at the extent of the physical processes study area. Average sedimentation is limited to <100 mm with peak values of *c*.70 mm, however outside the area of project physical work deposition is limited to negligible levels of <3 mm. Sedimentation one day after the cessation of trenching shows that fine sands and resuspended sediment settle during slack water.

The Douglas to Hamilton Main Inter-OP cable plume can be largely characterised by the Douglas to Lennox cable results, due to a highly similar route that diverges only slightly to reach the Hamilton Main OP. Similar average SSC values can be expected, with the greatest again occurring along the cable route itself. Likewise similar sedimentation values will be very similar and limited to <100 mm.

The Douglas to Hamilton North Inter-OP cable plume will differ slightly spatially, extending further to the north and reaching the extents of the physical processes study area, in some cases potentially leaving the boundary by small distances. Similar average SSC values can be expected, with the greatest again occurring along the cable route itself. Again, similar sedimentation values will be very similar to those experienced for the modelled cable routes.

The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI) receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

### Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern *Sterna hirundo* and little tern *Sternula albifrons*, the site regularly supports at least 20,000 waterfowl *Anseriformes sp*. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low**.**

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low**.**

The Ribble and Alt Estuaries SPA and Ribble Estuary SSSI is designated for its extensive areas of sandflats and mudflats, as well as large areas of saltmarsh. Ribble and Alt Estuaries is considered to be of high ecological value given these designations. These habitats support breeding populations of ruff *Philomachus pugnax*, common tern, and lesser black-backed gull *Larus fuscus graellsii* as well as a large number of winter bird, waterbird, and seabird assemblages. SSC is not a pathway to affect the designations and given the adaptability to low levels of sedimentation is considered to be of low vulnerability. The sensitivity of the receptor is considered to be negligible.

The Sefton Coast SSSI overlaps with the Ribble and Alt Estuaries SPA and Ribble Estuary SSSI, sharing the areas of sandflats and mudflats, as well as embryonic shifting dunes. As an SSSI the Sefton Coast is nationally designated and can be considered of high value. It is for these dunes and multiple sand bars occurring on the foreshore that the Sefton Coast is of special interest for coastal geomorphology. The site, as an active seabed feature, is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

Mersey Narrows and North Wirral Foreshore SPA and North Wirral Foreshore SSSI are overlapping sites designated for its extensive intertidal flats which support large numbers of feeding waders. Mersey Narrows and North Wirral Foreshore SPA and North Wirral Foreshore SSSI are considered to be of high ecological value given its international and national designations. The site supports breeding common tern and an internationally important waterbird assemblage. The sites, as active seabed features, are characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

The Flyde Marine Conservation Zone (MCZ) is designated due to its extensive areas of subtidal sediment habitats (sands and muds) which host plant and animal communities. MCZs are nationally designated sites and as such are of high value. Communities of flat fish, rays, crustaceans and bivalve species, are supported, and act as a food source for bird species such as the red throated diver *Gavia stellata*. The site, as an active seabed feature, is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is considered to be negligible.

### Significance of the effect

During the sand wave clearance across West Hoyle Bank, large plumes are produced, and likewise significant sedimentation is experienced, however it should be noted that the bank is an active bed feature which regularly undergoes change due to sediment redistribution. The vast majority of sediment that is mobilised at West Hoyle Bank is deposited adjacent to the seabed preparation and cable trenching pathway, and thus will be native material. Suspended sediment concentration increases are greatest along West Hoyle Bank itself with significant values up to *c*.1,400 mg/l directly adjacent to the dredge path. Average deposition along the immediate dredge path across the bank is up to *c*.3 m, however deposition across the physical processes study area more widely is negligible. Sediment plumes associated with the PoA Terminal to Douglas OP cable installation will also result in increased SSC over West Hoyle Bank. Concentrations are increased significantly however are highly localised along the cable path (mean SSC <1,000 mg/l, peak of *c*.750 mg/l), due to shallow waters, and are expected to be of a short duration.

The magnitude of the impact is deemed to be low due to limited and temporary nature of sediment plumes, and the sensitivity of the receptors are considered to be low due to the active and recoverable nature of the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Suspended sediments from sand wave clearance over West Hoyle Bank are also projected to be carried into the Dee Estuary SAC/SPA/SSSI, where they are deposited as far as 8 km into the designated sites but at negligible depths. The SSC rapidly decrease with distance from the sandbank, and within the Dee Estuary drop below 3 mg/l falling within background levels, likewise sedimentation values in the estuary are <3 mm.

Sediment plumes associated with the PoA Terminal to Douglas OP will result in increased SSC within the Dee Estuary SAC/SPA/SSSI. Average SSC values within the Dee Estuary incurred from cable installation are greatly reduced from those along the cable route, falling in the region of background concentrations (<3 mg/l). The sites mudflats and sandflats would remain stable and continue to support hydrodynamic processes, as well as the communities which utilise these habitats.

The magnitude of the impact is deemed to be low due to limited and temporary nature, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Due to the lack of SSC plume overlap and sedimentation with the Ribble and Alt Estuaries SPA, Ribble Estuary SSSI, Sefton Coast SSSI, Mersey Narrows and North Wirral Foreshore SPA, North Wirral Foreshore, and Flyde MCZ, there is no pathway for effect. Therefore, the magnitude of the impact is deemed to be no change, and the sensitivity of the receptors are considered to be negligible due to the recoverable nature of the designations. The effect will, therefore, be **no change**, which is **not significant** in EIA terms.

Processes such as sand wave clearance South of Douglas OP and monitoring well drilling, are deemed not to be significant to receptors given the limited spatial nature of plumes generated and sedimentation experienced, and distance from the various designated sites. Likewise, the Douglas to Lennox/Hamilton Main/Hamilton North Inter-OP cable installation is not foreseen to impact any receptor, given significant distance between designated sites and cable path.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

## 6.11.1.2 Operation and maintenance phase

### Magnitude of impact

There is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during the cable installation activities of the construction phase of the Proposed Development.

The MDS for maintenance activities that may affect physical processes relates only to potential maintenance works for the PoA Terminal to Douglas cables and Inter-OP cables. Repairs, reburial and replacement activities for sections or entire cable lengths may be undertaken as required from inspections. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired however the most onerous cable lengths have been quantified under the construction phase scenario discussed above.

The impact is predicted to be of local spatial extent, short term duration, intermittent and with high reversibility. As seen in the construction phase assessment, it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area, however, is not expected to affect any other receptors. The magnitude is, therefore, considered to be low for the receptors within the Dee Estuary SAC, SPA, SSSI.

### Sensitivity of the receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all proposed development phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

### Significance of the effect

For West Hoyle Bank the magnitude of the impact is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low for the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

The impact within the Dee Estuary is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

### 6.11.1.3 Decommissioning phase

#### Magnitude of impact

The MDS for decommissioning activities that may affect physical processes relates to the full removal of project infrastructure and equipment for disposal onshore. The expected magnitude of impact is therefore assumed at a worst-case equal to that of the construction phase as cables may be removed using a similar trenching process as that implemented for installation.

Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI) receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

#### Sensitivity of the receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all proposed development phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to decommissioning activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of decommissioning activities is therefore considered low and is impacted to a much the same degree than the construction phase.

#### Significance of the effect

For West Hoyle Bank the magnitude of the impact is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low for the West Hoyle Bank bedform. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

The impact within the Dee Estuary is deemed to be low due to limited and temporary nature of sedimentation, and the sensitivity of the receptors are considered to be low due to the recoverable nature of the Dee Estuary designations. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

#### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

## 6.11.2 Changes to seabed morphology due to sand wave clearance and cable protection measures

### 6.11.2.1 Construction phase

There is potential for changes to seabed morphology associated with various forms of seabed preparation activities, particularly sand wave clearance and dredging activities along the cable route. During the construction phase there will be gradual changes as infrastructure, in the form of cable crossings, is introduced into the environment. With changes and therefore potential impacts ranging from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (MDS) assessed in 6.11.2.2.

#### Magnitude of impact

In order to facilitate the laying of the POA to Douglas OP cable, the clearance of a number of sand waves south of the Douglas OP is required. This will take the form of two channels with lengths of 100 m and 15 m respectively, widths of 10 m, and depth of 3 m, created in the sand wave field through the use of a max flow excavator. The rate of reformation of sand waves is dependent on a range of factors including the size, location and alignment of any breach with respect to the sediment transport pathways and available recharge material. It has been shown that the region has active sediment transport systems with net sediment transport rates of circa 2 $m^3$/d/m within the physical processes study area and rates more than double this at sand wave crests. Increases in littoral currents during storm events would also significantly increase transport rates. The sand wave features themselves are also mobile, typically moving 1 to 4 m in an easterly direction each year (ABPmer, 2023b). The material which is cleared from the sand waves during seabed preparation will not be removed from the site, it will be relocated in close proximity to the sand wave such that it is readily available for recharge for the sand wave field south of Douglas OP.

The impact due to seabed preparation activities involving sand wave clearance within the sand wave field south of Douglas OP, is considered to be of local spatial extent, short term duration, intermittent and of high reversibility. The impact will directly affect the sand wave field along the cable route. Given the material removed from the sites will be deposited in the direct vicinity of the clearance operation, the magnitude of the impacts due to the seabed preparation activity is considered to be **low**.

To allow the laying of cable across West Hoyle Bank, a dredged channel will be required. Although an existing channel through West Hoyle Bank exists and offers a natural path within the area of project physical work for cable laying as can be seen in Figure 6.4, this channel is however not stationary, instead migrating east, which may make it unviable when the construction phase begins, the dredged channel is therefore considered as the worst-case scenario. As described in the Physical Processes Technical Report (RPS Group, 2024a), the dredged channel which is set to be 1 km in length, 7 m in depth, and 21 m in width, would see material removed from the bank within a 14 day period. Despite the volume of material being dredged from the bank, modelled scenarios of sediment suspension and deposition during the dredging operation, demonstrated that much of the material is deposited along the dredge path itself, supporting the fact the sediment will remain within the sediment cell and minimising loss to the feature (Section 6.11.1). Taking into account the eastward migration of the existing channel through West Hoyle Bank it is recommended as a mitigating measure that the placement of dredged material directly to the west of seabed preparation operations would aid in the recovery of morphological features such as West Hoyle Bank, and further encourage the feature to naturally infill. The temporary change to the morphology of the bank will have minimal impact on the feature’s ability to act as a natural breakwater for waves propagating towards the Dee Estuary. Given the location and orientation of the channel, cutting through the middle of the bank from its southern face to its northern face, there will be no change to the waves breaking on the west of the sand bank which is the principle direction from which larger storm events approach, as outlined in section 6.7.6.

The impact on seabed morphology due to the proposed dredged channel across West Hoyle Bank, is considered to be of local spatial extent, short term duration, intermittent and of high reversibility. The impact will directly affect West Hoyle Bank, along the cable route. Given the material removed from the bank will be deposited in the direct vicinity of the dredging works, the magnitude of the impacts due to seabed preparation activity is considered to be low.

### Sensitivity of the receptor

The zone of influence of the prepared works encompasses a sand wave field to the south of the Douglas OP, along the cable path. The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport which is to the east and are characterised by gradual east ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sandwave movement is also evident in Figure 6.3. The alteration to the coastal feature identified is localised and sediment displaced is expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is an area of shallow water creating rougher areas of wave stress and shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. A natural channel currently exists within the sand bank suitable for the laying of cable, intersecting from the north to south, however a worst-case scenario would see a channel dredged through the bank. The changes to seabed morphology are localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Significance of the effect

Due to the method of sand wave clearance, i.e., via the use of a max flow excavator, the sediment mobilised during the operation will predominantly settle in the immediate vicinity of the cleared channels, thus supplying ready sediment for the regeneration of cleared sand waves. This represents a short-term change in seabed morphology through altered bed levels, the changes to which fall within the areas range of natural variability (ABPmer, 2023b), due to the highly mobile nature of the sand waves and the eastward migration resultant from a flood dominated tide and the directionality of west to east sediment transport. The magnitude of the impact is deemed to be low due to the limited and temporary nature of the clearance operation, and the sensitivity of the receptor is considered to be low due to the active and recoverable nature of sand wave features across Liverpool Bay. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

During seabed preparation operations, in particular the dredging of a channel suitable for cable laying should this be undertaken through West Hoyle Bank a volume of sediment is to be mobilised, temporarily altering the morphology of the bank. However, this material is expected to remain within the sediment cell and settle in the direct vicinity of the dredged channel, as discussed in Section 6.11.1. The magnitude of the impact is deemed to be low due to the limited and temporary nature of the dredging operation, and the sensitivity of the receptor is considered to be low due to the active and recoverable nature of the West Hoyle Bank bedform. This could be further mitigated in line with the recommendation that dredged sediment be deposited to the immediate west of the dredged channel in order to facilitate natural infilling, in line with the dominant flood tide that drives sediment transport eastward. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

#### 6.11.2.2 Operation and Maintenance

Cable protection will be installed during laying of the cables during the Construction phase. There is no requirement for additional cable protection to be placed during the Operation and Maintenance phase. This section discusses any long term impact associated with the placement of cable protection during construction (i.e. any impacts that arise during the operation of the Proposed Development). The placement of cable crossings with other developments can be seen in Figure 6.17, the remaining crossings outlined within the maximum design scenario presented in Table 6.9 relate to the crossings at pipelines in the vicinity of the Douglas OP.

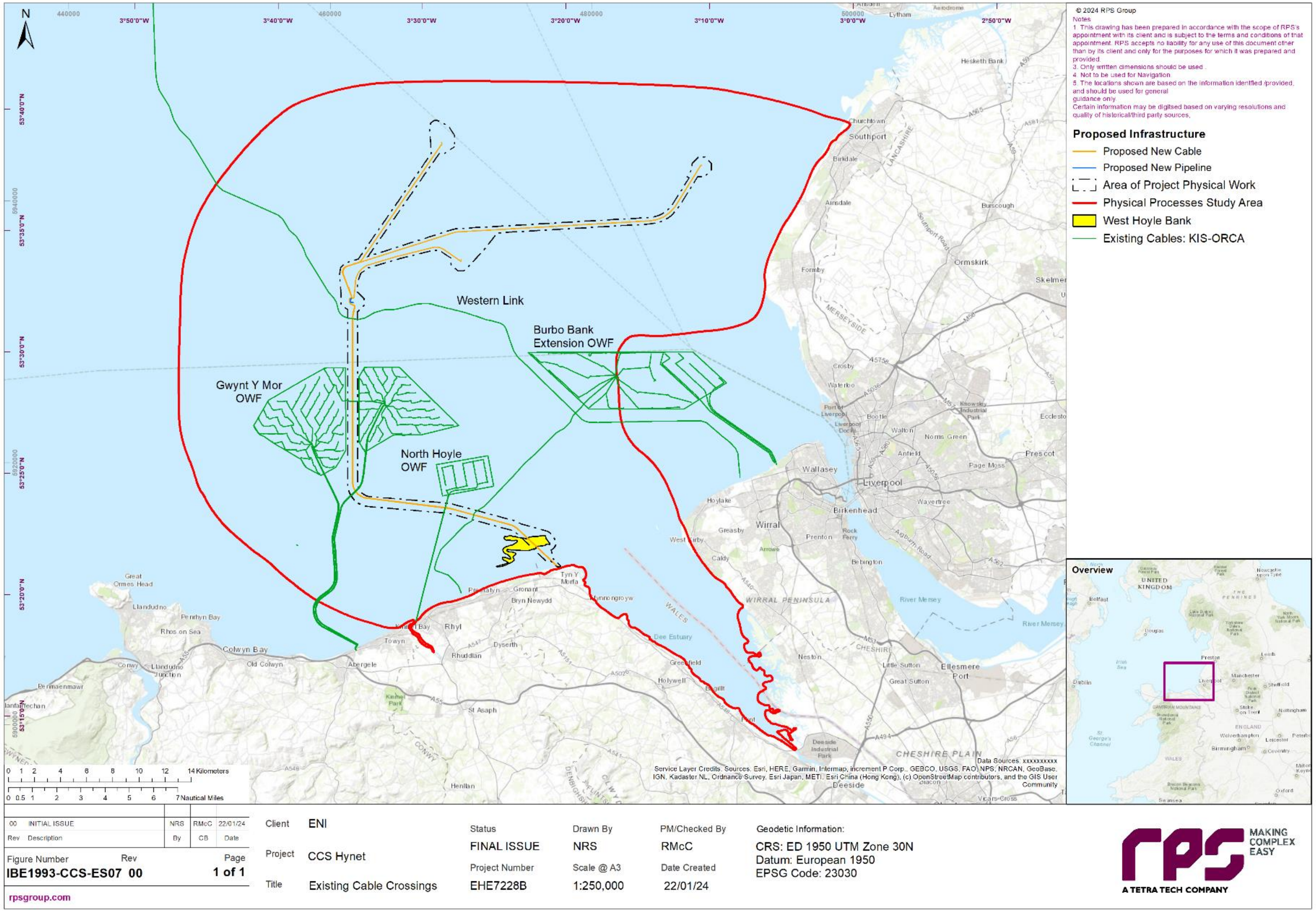


**Figure 6.17: Location of Cable Crossings with respect to Other Developments in Liverpool Bay**

### Magnitude of impact

The only cable protection measures to be utilised by the project occur in the form of cable crossings as the nature of the seabed sediment accommodates cable burial to the required depth. In total up to 32 cable crossings may be required, 10 of which relate to the POA to Douglas OP Cable, eight for the Douglas to Hamilton Inter-OP cable, eight for the Douglas to Hamilton North Inter-OP cable, and six for the Douglas to Lennox Inter-OP cable. Depending on the heights of such cable crossings, and the depth of water they are located in, there can be potential for changes to tide, wave and sediment transport processes due to a changed seabed morphology through altered bed levels. In this case however cable crossings will be up to a maximum height of up to 0.8 m, with widths of 7 m and tapered profiles to reduce the impacts to physical processes and seabed morphology. The cable crossings will be required in a range of depths from *c*. 5.8 m to *c*. 30.3 m (CD).

This includes the POA to Douglas OP cable crossing with the Burbo Bank Offshore Wind Farm Extension Export Cable, and further offshore POA to Douglas OP cable crossing with the Western HDVC Link Transmission Cable. Where practicable the requirements will be compliant with the Maritime and Coastguard Agency (MCA) navigation guidance which includes that there will be no more than a 5% reduction in water depth (referenced to Chart Datum) at any point along the cable route (MCA, 2021), without prior written approval from the Licensing Authority in consultation with the MCA. To exemplify just how minor changes to physical processes due to the presence of cable protection and altered seabed morphology would be, potential changes to the wave climate may be considered. Although this did not form part of the modelling study to assess changes to the wave climate within the assessment for the Proposed Development, a number of such studies have been carried out within close vicinity. One such being the Mona Offshore Wind Project PEIR (RPS Group, 2023b) and its associated modelling. The outcome of which indicated that where the cable protection height was less than circa 15% of the water depth there was no change in wave climate. In compliance with the MCA navigation guidelines discussed above, the maximum height of the shallowest cable crossing would be restricted to 5% of the water depth and therefore exhibit no change in wave climate, however, given a majority of cable crossings fall in waters deeper than 25 m (CD) they will change water depths to a much lesser degree than the 5% limit. With most of the crossings falling waters of c. 25 m (CD) which equates to 28 m mid tide, the introduction of 0.8 m cable crossing represents less than a 3% change in water depth and therefore likely < 3% change to tidal currents, which is a change a quarter of the size as exhibited in the natural variation between peak spring and peak neap tidal flows.

The impact due to cable crossings is considered to be of local spatial extent, long term duration, continuous and of high reversibility. Given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features, the magnitude of impact is therefore considered to be negligible.

### Sensitivity of the receptor

Locations of the cable protection for the proposed development vary in water depths and seabed morphology. For the most part these locations will fall in depth ranges wherein the bed level change due to the addition of cable crossings, will fall within the natural variability of water depths in the area, given the dynamic nature of seabed features such as sand waves and mega ripples within Liverpool Bay. The sensitivity of coastal features in these areas are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Significance of the effect

The magnitude of the impact is deemed to be negligible due to the imperceptible change to physical processes and the limited change to seabed morphology in the vicinity of the cable crossings associated with the Proposed Development. The sensitivity of the receptor is considered to be low due to the active and dynamic nature of the seabed in Liverpool Bay. The potential impact is further reduced through mitigation measures such as a maximum height of 0.8 m, a tapered profile, and compliance with MCA navigation guidance. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms. It should be noted that procedural monitoring will be able to identify any changes to cable protection and seabed morphology during the operation phase (Section 6.10).

## 6.11.2.3 Decommissioning phase

### Magnitude of impact

During decommissioning all project infrastructure will be removed from the seabed in accordance with existing UK legislative aims. The nature of the impact will depend on the method used to remove cables but, as a worst cases, removal will be undertaken using similar techniques as installation. Thus, in the decommissioning phase impacts to seabed morphology will take a similar form as those experienced in the construction phase, with bedforms such as sand waves and West Hoyle Bank requiring (in a worst-case scenario) sand wave clearance before removal. Given the dynamic nature of the seabed within the physical processes study area it is possible that a greater or lesser number of sand waves will require clearance in order to remove cables, it can be considered however in line with the construction phase that the temporary clearance of these features represents a temporary change to an already dynamic seafloor, and thus can be considered to be of local spatial extent and recoverable. The magnitude of impacts associated with decommissioning activities are therefore considered to be low.

### Sensitivity of the receptor

The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport, which is to the east, and are characterised by gradual eastward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sandwave movement is also evident in Figure 6.3. The alteration of coastal features from decommissioning activities much like the construction phase would be localised and sediment displaced expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

A worst-case scenario would see a channel similar to that created in the construction phase, dredged through the bank. The changes to seabed morphology would again be localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Significance of the effect

Given that cable removal techniques will likely be similar to those used for installation, it can be expected that sediment suspended during decommissioning activities will follow a similar trend in deposition and settle within the direct vicinity of the works, providing ample sediment for bedform regeneration or infilling. Again, resulting impacts would represent a short-term change in seabed morphology through altered bed levels, the changes to which fall within the areas range of natural variability (ABPmer, 2023b). This is due to the highly mobile and dynamic nature of the seabed features within the physical processes study area. The magnitude of the impact is deemed to be low due to the limited and temporary nature of decommissioning activities, and the sensitivity of receptors are considered to be low due to the active and recoverable nature of seabed features across

Liverpool Bay. The effect will, therefore, be of **minor** adverse significance, which is **not significant** in EIA terms.

#### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

## 6.11.3 Activities affecting surrounding water quality

### 6.11.3.1 Construction phase

Construction activities conducted near the shoreline (e.g. trenching for the cable route) could impact water quality in proximity to the coastline through increased SSC which could then impact the local tidal regime and wave climate. Increased SSCs could cause toxicity effects through mobilisation of contaminated sediments which would potentially affect the surrounding water quality through the local tidal regime and wave climate.

Increases in SSCs could also generate sediment plumes, which may decrease the depth to which natural light could penetrate the water column. In turn, this could reduce primary production and/or increase bacterial growth, which could cause contamination to marine species, particularly shellfish.

Construction vehicles and vessels have the potential to cause accidental spills and pollution within the area of project physical work and the surrounding footprint.

#### Magnitude of impact

As stated in section 6.7.8, sediment contamination within the Eni Development Area was assessed during the site-specific benthic characterisation survey in 2022, and the following results were recorded:

- As and Cd exceeded Cefas AL1 at one sampling station each.
- Hg was above the OSPAR BAC levels in seven sampling stations but did not exceed Cefas ALs.
- Zn was the most abundant metal across all samples but concentrations never exceeded any reference levels. All metals occurred in concentrations comparable to existing background data or in line with the range of concentrations known for areas located in proximity of active platforms.
- Chrysene and benzo[a]pyrene were above Cefas AL1 at one sampling station. A positive correlation was observed between chrysene, benzo[a]pyrene and mud content with higher PAHs concentrations in muddier sediments. No relationship was observed between the concentration of PAHs and proximity to platforms that could have indicated dispersal of drill cuttings.
- THC levels were in line with values associated with oil and gas platforms.
- PCBs and did not exceed Cefas AL1 at any sampling stations.
- Organotins were below the limit of detection at all sampling stations.

Based on these sediment contamination results, it is not likely that significant levels of sediment bound contaminants could be released as a result of the construction activities. Furthermore, the magnitude of impact for 'Increased SSCs and Associated Deposition' was concluded to be negligible to low (section 6.11.1). This low to negligible magnitude of impact further reduces the possibility for the release of sediment bound contaminants and increased bacterial growth to have an effect on water quality.

Water quality could also be affected by accidental pollution from vessels in the construction phase. The MDS for this impact assumes a total of 236 round trips by vessels over the duration of the construction phase (Table 6.9). These include cable installation vessels, jack-ups, and support vessels. There is also potential for accidental pollution through discharges of drill cuttings, drilling mud, and cement, during the drilling of monitoring wells. However, as stated in section 6.10, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring. The of development and adherence to an EMP (including a MPCP) will include planning for accidental spills, address all potential contaminant releases, and include key emergency details. Measures will also be adopted to ensure that the potential for release of pollutants is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds. Finally, all vessels will be required to comply with the MARPOL regulations.

Overall, this impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary SAC, SPA and SSSI receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

### Sensitivity of receptor

The receptors are described above in section 6.11.1, for the impact of increased SSCs and associated deposition. The receptors include a wide range of habitats, including sandbanks, sandflats, mudflats, estuaries, saltmarsh, and embryonic, shifting and fixed dunes. In turn, these habitats support rich mosaics of biodiversity, and a range of benthic, fish and shellfish, marine mammal, and ornithological species. Many of the receptors are protected under national and international designations, such as SACs, SPAs, SSSIs, and MCZs. The species that rely on the various receptors' habitats are likely to be sensitive to this impact, given the known toxicity and potential for bioaccumulation of many of contaminants (as outlined in sections 6.7.8 and 6.7.11). Therefore, all receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

### Significance of the effect

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

## 6.11.3.2 Operation and maintenance phase

Operation and maintenance activities could affect water quality through mobilisation of contaminated sediments through sediment disturbance during cable repair activities during operation which could potentially affect the surrounding water quality. In addition, vessels associated with operation and maintenance activities have the potential to cause accidental spills and pollution within the area of project physical work and the surrounding footprint. Changes to water quality due to the presence of cable protection measures may also occur, as a result of secondary scour.

### Magnitude of impact

As described above for the construction phase, there Eni Development Area was surveyed for a range of potential contaminants which could be disturbed by increased SSCs and associated deposition. In the operation and maintenance phase, there is potential for increases in SSCs and deposition from activities related to cable repair and/or removal. These effects are likely to be similar to those exhibited during the cable installation activities of the construction phase. The magnitude of impact of increased SSCs and associated deposition in the operation and maintenance phase is as described in section 6.11.1 above and not repeated here.

Furthermore, the MDS for this impact assumes a total of 750 round trips by vessels over the duration of the operation and maintenance phase (Table 6.9). However, as above for the construction phase, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring and having an effect on water quality.

The MDS for cable protection from the PoA Terminal to Douglas OP includes cable protection at up to 10 locations for cable crossings along the route between 5.8 m and 30.8 m water depth, with a height of up to 0.8 m and a width of up to 7 m. Between Douglas OP and Lennox OP the MDS for cable protection assumes up to six locations, between Douglas OP and Hamilton North OP assumes up to eight locations, and between Douglas OP and Hamilton OP assumes up to eight locations, all with a height of up to 0.8 m and a width of up to 7 m.

Overall, for mobilisation of contaminated sediments and accidental pollution, this impact is predicted to be of local spatial extent, short term duration, intermittent throughout the operation and maintenance phase, and have high reversibility. As seen in the construction phase, it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area. The magnitude is, therefore, considered to be low for the receptors within the Dee Estuary SAC, SPA, SSSI and of negligible magnitude to other receptor groups.

For changes to water quality due to the presence of cable protection measures, this impact is predicted to be of local spatial extent, long term duration, permanent throughout the operation and maintenance phase, and of high reversibility. As outlined above in section 6.11.2.2, given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to experience significant secondary scour, the magnitude of impact is therefore considered to be negligible.

### Sensitivity of the receptor

The sensitivity of the receptors is as described above for the construction phase: all receptors are deemed to be of high vulnerability and low recoverability. Therefore, the sensitivity is considered to be high.

### Significance of the effect

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be negligible to low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or minor to moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

### Secondary mitigation and residual effect

No Physical Processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 6.10) is **not significant** in EIA terms.

#### 6.11.3.3 Decommissioning phase

**Magnitude of impact**

The MDS for decommissioning activities that may affect physical processes relates to the full removal of proposed development infrastructure and equipment for disposal onshore. The expected magnitude of impact is therefore assumed at a worst-case equal to that of the construction phase as cables may be removed using a similar trenching process as that implemented for installation.

Furthermore, the MDS for this impact assumes a total of 128 round trips by vessels over the duration of the decommissioning phase (Table 6.9). However, as above for the construction and operation and maintenance phases, embedded mitigation (e.g., an EMP) will reduce the likelihood of accidental pollution occurring and having an effect on water quality.

Therefore, the impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the West Hoyle Bank, and Dee Estuary SAC, SPA and SSSI receptor directly whilst affecting the remaining receptors indirectly. The magnitude is therefore considered to be low for the West Hoyle Bank feature and the Dee Estuary designations, and of negligible magnitude to other receptor groups.

**Sensitivity of the receptor**

The sensitivity of the receptors is as described above for the construction phase: all receptors are deemed to be of high vulnerability and low recoverability. Therefore, the sensitivity is considered to be high.

**Significance of the effect**

Overall, for the West Hoyle Bank and Dee Estuary designations, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be high. As per Table 6.13, this yields a minor or moderate significance. The effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

For all other receptors, the magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

## 6.12 Cumulative effect assessment methodology

The Cumulative Effect Assessment (CEA) takes into account the impact associated with the Proposed Development together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise  see volume 3, appendix F). Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The physical processes CEA methodology has followed the methodology set out in volume 1, chapter 5. This involved taking a tiered approach was adopted. This provided a framework for placing relative weight upon the potential for each project/plan included in the CEA, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach to the CEA is as follows:

- Tier 1:
  - under construction;
  - permitted application;

  - submitted application; and
  - those currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact.
- Tier 2:
  - the scoping report has been submitted and is in the public domain.
- Tier 3:
  - the scoping report has not been submitted and is not in the public domain;
  - identified in the relevant development plan for the Proposed Development; and
  - identified in other plans or programmes.
- Tier 4:
  - no publicly available information.

The details of specific projects, plans and activities scoped into the CEA, are outlined in Table 6.15 and presented in Figure 6.18.

**Table 6.15: List of Other Projects, Plans and Activities Considered within the CEA**

| Project/Plan | Status | Distance from the Proposed Development (nearest point, km) | Distance from the Area of Project Physical Work (nearest point, km) | Description of Project/Plan | Dates of Construction (if applicable) | Dates of Operation (if applicable) | Overlap with the Proposed Development |
|---|---|---|---|---|---|---|---|
| **Tier 1 - Dredging Act and Dredge Disposal Sites** | | | | | | | |
| Burbo Bank Extension OWF Disposal Site (Ørsted 2013) | Open | 0.50 | 12.80 | The disposal of up to 6,800 metres$^3$ of inert material of natural origin produced during the drilling installation of monopiles or jacket foundations at disposal site reference IS135 Burbo Bank Extension OWF. | N/A | Unknown | Yes |
| Port of Mostyn Ltd DML1542 | Unknown | 4 | 4 | Deposit of up to 188,750 m$^3$ material dredged under licence DML1542 for the construction of the quay. | N/A | 1 May 2019 to 30 April 2025 | Yes |
| Port of Mostyn Ltd DML2001 | Unknown | 4 | 4 | Maintenance dredging of harbour. | N/A | 12 October 2020 to 31 March 2026 | Yes |
| Mostyn Breakwater Disposal Site | Open | 6 | 6 | Disposal site associated with Port of Mostyn works. | N/A | Unknown | Yes |
| **Tier 1 - Marine Minerals** | | | | | | | |
| Hilbre Swash Marine Aggregate Extraction | Operational | 0 | 3.0 | Extraction of up to 12 million tonnes of aggregate (mainly sand) over the course of 15 years at a maximum annual rate of 1.2 million tonnes and an average annual rate of 0.8 million tonnes. | N/A | 1 January 2014 to 1 January 2030 | Yes |
| **Tier 1 - Offshore Renewables** | | | | | | | |
| Awel y Môr Offshore Wind Farm (RWE | Consented | 0 | 1.70 | Offshore wind development application providing for a maximum of 50 turbines, associated transmission assets, and | 2024 to 2029 | 1 January 2030 to 1 January 2055 | Yes |

| Project/Plan | Status | Distance from the Proposed Development (nearest point, km) | Distance from the Area of Project Physical Work (nearest point, km) | Description of Project/Plan | Dates of Construction (if applicable) | Dates of Operation (if applicable) | Overlap with the Proposed Development |
|---|---|---|---|---|---|---|---|
| Renewables Ltd, 2022) | | | | inter array, interlink and export cables. Generation in excess of 500 MW. | | | |
| **Tier 1 - Construction and Decommissioning** | | | | | | | |
| Burbo Bank Extension Cable Reburial | Consented/Licensed | 0 | 12.80 | Provision for emergency cable reburial where areas have become exposed. | N/A | 20 July 2017 to 01 September 2027 | Yes |
| Gwynt y Môr Offshore Wind Farm | Variation Granted | 0 | 0.30 | Removal of the Gwynt y Môr Wind Farm meteorological mast which includes topside lattice structure removal, monopile removal, scour protection removal and a seabed survey. | N/A | 18 April 2019 to18 April 2029 | Yes |
| Mostyn Energy Park Extension (MEPE) | Submitted | 2.3 | 2.3 | Extension of the Mostyn Energy Park at the Port of Mostyn. Requires construction of a 360 m quay, reclamation of 3.5 ha area, capital dredging of new berth pockets and re-dredging of approach channel. Use of dredged material for fill material for reclamation, disposal of dredged material at Mostyn Deep. Maintenance dredging of new and existing berths, approach channel and harbour area. | 2023 to 2025 | 2025 to 2030 | Yes |
| Mona Offshore Wind Farm Suction Bucket Trials | Consented/Licensed | 5.60 | 9.0 | The works proposed within this Marine Licence Application consist of trialling suction bucket foundations to assess the install viability within the Mona array area, which is predominantly within Welsh waters. | 2023 to 2024 | N/A | Yes |

| Project/Plan | Status | Distance from the Proposed Development (nearest point, km) | Distance from the Area of Project Physical Work (nearest point, km) | Description of Project/Plan | Dates of Construction (if applicable) | Dates of Operation (if applicable) | Overlap with the Proposed Development |
|---|---|---|---|---|---|---|---|
| Colwyn Bay CRMP | Consented/Licensed | 14.30 | 14.30 | Beach recharge of Colwyn Bay as part of the Colwyn Bay Waterfront Project – Phase 2b. | N/A | 18 April 2019 to18 April 2029 | Yes |
| **Tier 1 - Cables and Pipelines** | | | | | | | |
| Mares Connect | Permitted | 0 | 0 | Mares Connect is a proposed 750 MW subsea and underground electricity interconnector system linking the electricity grids in Ireland and Great Britain. | 2025 to 2027 | 2027 onwards | Yes |
| **Tier 2 - Offshore Renewables** | | | | | | | |
| Mona Offshore Wind Project (RPS Group, 2023b) | Pre-application PEIR submitted | 5.60 | 9.0 | 1.5 GW Offshore wind farm with installation of associated turbine and OSP foundations, along with inter array/ export cables. | 2026 to 2029 | 2030 to 2065 | Yes |

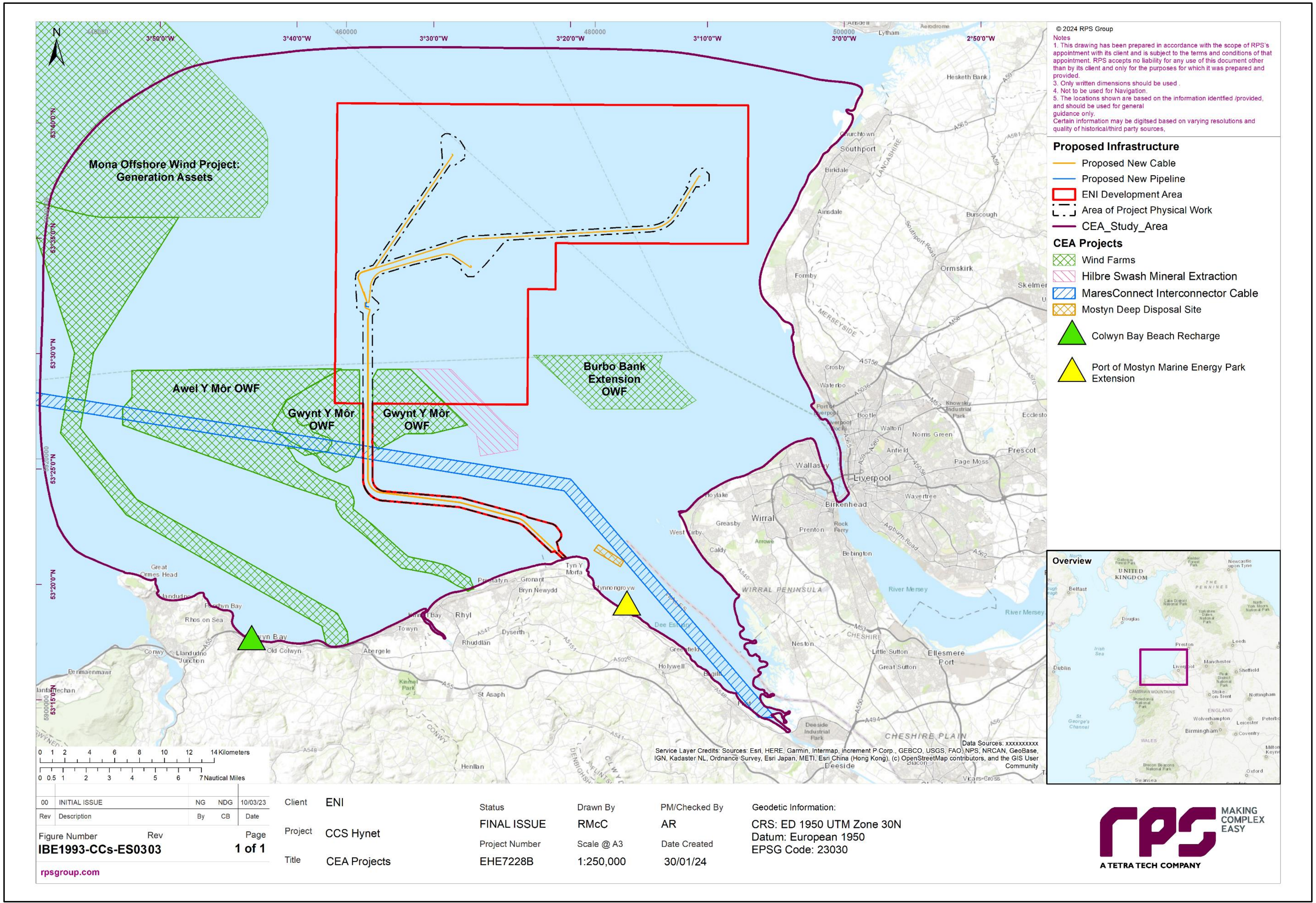


**Figure 6.18: Other Projects, Plans and Activities Screened into the Cumulative Effects Assessment**

### 6.12.1 Maximum design scenario – cumulative effects assessment

The maximum design scenarios identified in have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the PDE provided in volume 1, chapter 3 as well as the information available on other projects and plans, in order to inform a ‘maximum design scenario’. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different foundation type or substation layout), to that assessed here, be taken forward in the final design scheme.

**Table 6.16: Maximum Design Scenario for the Assessment of Cumulative Effects**

| Potential Impact | Phase[a] C | O | D | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| Increased suspended sediment concentrations (SSCs) and sediment deposition | ✓ | ✓ | ✓ | Maximum design scenario as described for the Proposed Development assessed cumulatively with the following other projects/plans:<br>No onshore/intertidal activities related to the Proposed Development that may cause a cumulative effect.<br>**Tier 1**<br>**Construction phase**<br>• construction of Awel y Môr Offshore Wind Farm;<br>• operation of Hilbre Swash sand extraction;<br>• construction and operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal;<br>• operation of Burbo Bank Extension OWF disposal site;<br>• reburial of Burbo Bank Extension OWF cabling;<br>• removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection;<br>• Colwyn Bay beach recharge;<br>• construction of the MaresConnect UK to Ireland Interconnector Cable; and<br>• Construction and operation of suction bucket trials for the Mona Offshore Wind Farm.<br>**Operation and maintenance phase**<br>• construction and operation of Awel y Môr Offshore Wind Farm;<br>• operation of Hilbre Swash sand extraction; and<br>• removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection.<br>**Decommissioning phase**<br>• no tier 2 projects overlap with the Proposed Developments decommissioning phase. | Outcome of the CEA will be greatest when the greatest number of other schemes are considered in combination. Including schemes and developments within the CEA study area to capture the potential overlap of impacts during the construction, operations and maintenance and decommissioning phases. Activities from schemes that potentially increase suspended sediment concentrations during the temporal overlap with the Proposed Development phases have been included as these may create a cumulative impact on physical features/ receptors. |

| Potential Impact | Phase[a] C | O | D | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | | | | **Tier 2**<br>**Construction phase**<br>• construction of the Mona Offshore Wind Project.<br>**Operation and maintenance phase**<br>• construction and operation of the Mona Offshore Wind Project.<br>**Decommissioning phase**<br>• operation of the Mona Offshore Wind Project. | |
| Changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures | ✓ | ✓ | ✓ | Maximum design scenario as described for the Proposed Development assessed cumulatively with the following other projects/plans:<br>No onshore/intertidal activities related to the Proposed Development that may cause a cumulative effect.<br>**Tier 1**<br>**Construction phase**<br>• construction of Awel y Môr Offshore Wind Farm;<br>• operation of Hilbre Swash sand extraction;<br>• construction and operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal;<br>• operation of Burbo Bank Extension OWF disposal site;<br>• reburial of Burbo Bank Extension OWF cabling;<br>• Colwyn Bay beach recharge;<br>• construction of the MaresConnect UK to Ireland Interconnector Cable; and<br>• Construction and operation of suction bucket trials for the Mona Offshore Wind Farm<br>**Operation and maintenance phase**<br>• construction and operation of Awel y Môr Offshore Wind Farm;<br>• operation of Hilbre Swash sand extraction;<br>• operation of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities and disposal;<br>• removal of Gwynt y Môr Offshore Wind Farm meteorological mast including lattice, foundations and scour protection; and<br>• operation of the MaresConnect UK to Ireland Interconnector Cable. | Changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures. |

| Potential Impact | Phase[a] C | O | D | Maximum Design Scenario | Justification |
|---|---|---|---|---|---|
| | | | | **Decommissioning phase**<br>• no tier 1 projects overlap with the Proposed Developments decommissioning phase.<br>**Tier 2**<br>**Construction phase**<br>• construction of the Mona Offshore Wind Project.<br>**Operation and maintenance phase**<br>• construction and operation of the Mona Offshore Wind Project.<br>**Decommissioning phase**<br>• operation of the Mona Offshore Wind Project. | |
| Activities affecting surrounding water quality | ✓ | ✓ | ✓ | The MDS is as above for increased SSCs and associated deposition for all phases, and consistent with the MDS for changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures additionally for the operation and maintenance phase. | The justification is as above for increased SSCs and associated deposition and changes to seabed morphology in the subtidal environment due to sand wave clearance and cable protection measures. |

[a] C=construction, O=operation and maintenance, D=decommissioning

# 6.13 Cumulative effects assessment

A description of the significance of cumulative effects upon physical processes receptors arising from each identified impact is given below.

## 6.13.1 Increased suspended sediment concentrations and sediment deposition

### 6.13.1.1 Construction phase

#### Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed project cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern and little tern, the site regularly supports at least 20,000 waterfowl. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. The sedimentation identified is localised and composed of native material therefore the structure and function of sandbanks is of low vulnerability and recoverable as the active sandbank system is naturally exposed to significant sediment redistribution. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

#### Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from seabed preparation involving sand wave clearance, the drilling of monitoring wells, and the installation of cabling have been assessed as negligible for the Proposed Development alone, as described in section 6.11.1. With the cable corridor passing through the Dee Estuary SAC, SPA, and SSSI designations and the West Hoyle Bank Annex 1 habitat, these receptors would be directly affected. The installation of the PoA to Douglas OP cable results in increased SSC and deposition within the Dee estuary designations, with average deposition values reaching in excess of 100 mm. These values reduce greatly with distance however, decreasing to within 100 m with sedimentation levels within the immediate vicinity of the trench circa 3 m and reducing to <10 mm within 100 m. West Hoyle experiences even greater impact during the sand wave clearance preceding cable installation, here sedimentation can be as great as c.3 m along the dredging route, again values decrease with distance from the source, falling to <5 mm within 100 m.

##### Tier 1

The construction phase of the Proposed Development is expected to coincide with the proposed development of Awel y Môr Offshore Wind Farm. The MDS for potential changes to SSC and deposition at Awel y Môr Offshore Wind Farm provides for pre-lay cable trenching using a Mass Flow Excavator (MFE), sand wave clearance (MFE), cable installation through jetting, dredge spoil disposal at surface, and drill cuttings produced by foundation installation. Construction activities may result in increased SSC and given the close proximity of works it is likely that there will be interaction with sediment plumes from the Proposed Development. Plumes produced during drilling and sand wave clearance activities within the Awel y Môr Array Area may reach the Proposed Development's area of project physical work at up to 50 mg/l on flood tides, with greater interaction at spring tides. Likewise, plumes produced through pre-lay cable trenching within the Awel y Môr Export Cable Corridor may overlap directly with the Proposed Development's area of project physical work though do so at lower values *c*.5 mg/l and are only likely to occur if trenching activities occur simultaneously. The Awel y Môr Offshore Wind Farm, also involves the installation of an interlink cable with the Gywnt y Môr Offshore Wind Farm, with the magnitude of suspended sediments likely being of a similar magnitude to export cable installation. Thus, again it can be expected a cumulative effect that may arise would do so within the natural variability of background levels, and only occur if cable installation operations occurred simultaneously. Cumulative deposition may occur between the PoA to Douglas cable trenching and the foundation drilling with the Awel y Môr Array Area, however, interaction is expected to occur at *c*. <1 mm. There is potential for cumulative impacts between simultaneous cable installation or seabed preparation activities prior to cable installation to cause coalesced plumes within the Dee Estuary designations and/or over West Hoyle Bank. However, the magnitude of the cumulative change would be minimal with suspended sediment concentrations from Awel y Môr construction activities reaching the receptors at background values. These cumulative impacts are expected to remain of limited magnitude due to the rapid decrease in SSC and deposition with distance from the source of sediment disturbance.

The construction phase of the Proposed Development also occurs within the same time frame as a number of smaller construction/decommissioning projects, such as beach recharging at Colwyn Bay and the removal of the Gwynt y Môr met mast situated within the Gwynt y Môr Offshore Wind Farm. In the case of Colwyn Bay, suspended sediments and related deposition caused by beach recharging/nourishment are expected to be of local extent and small magnitude. No cumulative impact is expected to arise here as the extent of plumes (<0.1 mg/l) produced by the trenching of PoA to Douglas cables are located *c*.10 km from Colwyn Bay. Interaction may occur between the trenching of PoA to Douglas cables and the removal of the Gwynt y Môr met mast if activities happen simultaneously, as the Gwynt y Môr Array Areas are completely encompassed by the SSC plume generated by the Proposed Developments cable installation. Though a cumulative impact may occur, the magnitude is expected to be negligible, of local extent and short-term duration. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. This development within the Dee Estuary, involves the construction of a 360 m length of new quay wall, the infilling of a 3.5 hectare area behind the new quay wall (requiring *c*.600,000 $m^3$ of infill material 500,000 $m^3$ of which will be sourced from dredging activity arisings). Alongside the new quay wall a dredged berth pocket will be required to a depth of - 11 m CD (*c*. 400,000 $m^3$), whilst re-dredging of the existing berth pocket along the existing quay wall to – 9 m CD will be required (*c*. 400,000 $m^3$). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of – 4 m CD (*c*. 3 million $m^3$). The operation and maintenance phase will again involve dredging activities of the new and existing berths, harbour, and approach channel (*c*. 499,995 $m^3$), and the disposal of resulting dredged material in the existing disposal sites. Both seabed preparation and cable installation activities produce SSC plumes that extend into the Dee Estuary and overlap with the location of construction activities and dredging at the Port of Mostyn MEPE, however, they do so at background levels i.e., < 3 mg/l. It can therefore be judged that although a cumulative impact may arise within the Dee Estuary receptors, the change in SSC would be of negligible significance and recoverable.

The largest overlap in SSC would occur if the disposal of dredged material within the Mostyn Deep disposal site occurred simultaneously with cable installation activities or seabed preparation across West Hoyle Bank, however even in this case overlapping plumes in the vicinity of West Hoyle Bank and within the Dee Estuary would be of limited magnitude due to the decreases in SSC and deposition observed with distance from respective works. Noting also that sediment plumes would be traversing in parallel and not towards one another as they are advected on the same tidal current. Maximum SSC values in the area of overlap can be up to 100 mg/l for both plumes however the more representative average plumes are expected to coincide with values of negligible difference to background levels, likewise sedimentation over the bank can be considered minor and the overall cumulative impact between the disposal of dredged material and the Proposed Development can be considered to be negligible, of local extent and short-term duration. The cumulative impact relating to overlap between operation and maintenance activities from the Mostyn Energy Park Extension and construction activities related to the Proposed Development are expected to be similar of a similar magnitude to the dredging/ disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works instead of construction works and can therefore can be considered to be negligible, of local extent and short-term duration.

The Proposed Development's construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell and only mobilised as a side-effect, it is not expected that the resultant SSC plume will be substantial enough to interact with the Proposed Development at significant concentrations, however minimal cumulative deposition <1 mm may occur. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable reburial, should the need arise, is found in close proximity to the physical processes study area. Depending on the location and scale of the reburial events, there is a possibility for plume overlap with the installation of the PoA to Douglas OP cable, SSCs from construction activities were shown to travel up to 10 km during ebb spring tides. However, SSC plumes associated with the Proposed Developments cable installation would reach Burbo Bank extension at levels of <3 mg/l (this being in line with background turbidity levels). With the resulting cumulative deposition likely to fall below 1 mm. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

During the construction phase of the Proposed Development the Mares Connect cable will be in construction which may result in increased suspended sediment concentrations, the cable directly intersects the PoA to Douglas OP export cable from the Proposed Development. The trenching activities for both projects may run concurrently, and interaction of SSC plumes may occur. However, the concentration of suspended sediment would reduce significantly moving further from the PoA to Douglas trenching route with interacting plumes falling below 10 mg/l within 20 m of the Proposed Developments. Additionally, the suspended sediments mobilised by the Mares Connect cable may interact with those from the Proposed Development's sand wave clearance works across West Hoyle Bank. Cumulative changes would however be expected to fall within background values of <10 mg/l and given the nature of the receptor as an active bedform would be highly recoverable.

As part of the Mona Offshore Wind Farm application, a series of suction bucket foundation trials were consented to, in order to validate the suitability of foundation and optimise design. These works occur within the Mona Array Area at up to 30 locations, using a variety of parameters to best inform final design. At each location the trial may be undertaken up to 3 times and once all activities at the site are complete the full removal of foundation would occur before moving to the next location to repeat. Although the trials of foundation installation and subsequent removal may mobilise sediment within the Mona Array Area, the small scale nature associated with the installation/removal of one foundation at a time would be expected to produce a small plume with much of the sediment suspended settling in the vicinity of the structures. This paired with the fact that the Mona Array Area is largely advected on tidal currents and situated c. 9 km North West of the Proposed Development (at its closest point), indicate that if an overlap in SSC or deposition did occur between the projects, that it would do so at background levels.

### Tier 2

The construction phase of the Tier 2 development Mona Offshore Wind Project coincides with that off the Proposed Development. Interaction between suspended sediment plumes may occur should trenching activities be undertaken simultaneously however this is unlikely given the length of construction phase and range of activities. SSC plumes are expected to reach background levels before overlapping with the Proposed Development and additionally plume would not directly interact as they would run in parallel. Cumulative deposition may occur given that the plumes from the Proposed Development may travel up to 15 km west which coincides with the Mona offshore export cable sand wave clearance and cable installation plumes. Cumulative deposition would however be minimal with values <1 mm, and all sediment retained within the sediment cell. No cumulative effect with the Proposed Development is expected to affect relevant receptors.

#### Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.1.2 Operation and maintenance phase

### Sensitivity of receptor

The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains the same as for all construction phases.

The Dee Estuary site would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

West Hoyle Bank is an active bedform feature characterised by sediment redistribution and would recover from the sedimentation which may occur due to maintenance activities. The material released is native to the sediment cell and the minimal sedimentation would be localised. The sensitivity of the receptor to changes as a result of maintenance activities is therefore considered low and is impacted to a much lesser degree than the construction phase.

### Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from maintenance activities during operations and maintenance phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Maintenance activities may involve the repair, removal, or replacement of the PoA to Douglas OP and Inter-OP cables. it is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank if cable maintenance is required in the nearshore area, however, is not expected to affect any other receptors. Impacts due to maintenance works are expected to be of a similar magnitude as those observed in the construction phase associated with cable installation, if not significantly reduced.

#### Tier 1

The cumulative impact assessment considers the construction, and operation and maintenance phases of Awel y Môr Offshore Wind Farm with the operation and maintenance phase of Proposed Development. The cumulative impacts are expected to be the same as those described for each project in the construction phase only reduced in magnitude. This due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale and be less numerous.

The Proposed Development’s operation and maintenance phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the proposed location of the PoA to Douglas OP cable. As described for the construction phase nature of the project as an extraction operation where sediment is being removed from the cell and only mobilised as a side-effect, it is not expected that the resultant SSC plume will be large enough to interact with the Proposed Development at significant concentrations. Additionally given the intermittent nature and smaller scale of work, cumulative impacts during the Proposed Development operation and maintenance phase are likely to be of a smaller magnitude than during the construction phase.

As described in the construction phase, the Proposed Development operations and maintenance phase also overlaps with the decommissioning and removal of the Gwynt y Môr met mast. The magnitude of impact is expected to be similar to that described for the construction phase if cable repair/reburial or replacement was to occur in the PoA to Douglas OP cable sections adjacent to the Gwynt y Môr Array Area. However, impacts are expected to be reduced due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale and be less numerous.

**Tier 2**

The cumulative impact assessment considers the construction, and operation and maintenance phase of the Mona Offshore Wind Farm coinciding with the operation and maintenance phase of Proposed Development. The magnitude of cumulative impacts are expected to be the same as those described for the project in the construction phase only reduced. This due to the nature of maintenance activities being both intermittent and a smaller scale than that of the construction phase and therefore any potential cumulative impacts are less likely to occur and be on a smaller scale.

**Cumulative effect**

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.1.3 Decommissioning phase

### Sensitivity of receptor

The Dee Estuary SAC, SPA, and SSSI overlap with the proposed project cable route and experiences suspended sediments and deposition as a result of seabed preparation and cable installation activities. The site is designated for its mudflats and sandflats not fully covered by seawater at low tide, saltmarsh habitat, estuaries, and embryonic, shifting, and fixed dunes. These habitats support a wide range of both nationally and internationally important wintering species as well as breeding populations if common tern and little tern, the site regularly supports at least 20,000 waterfowl. The Dee Estuary is considered to be of high ecological value given its numerous international and national designations. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is not a designated site but supports sandbanks which are an Annex 1 habitat of the EC Habitats Directive. West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes, acting as a natural breakwater to the Dee Estuary. The sedimentation identified is localised and composed of native material therefore the structure and function of sandbanks is of low vulnerability and recoverable as the active sandbank system is naturally exposed to significant sediment redistribution. The sedimentation identified is localised and composed of native material, furthermore as an active sandbank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

#### Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from decommissioning activities during the decommissioning phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Decommissioning activities will involve the removal of all project infrastructure and equipment for disposal onshore. It is predicted that the impact may directly affect the Dee Estuary SAC, SPA, SSSI, and West Hoyle Bank when the removal of assets is required in the nearshore area, however, is not expected to affect any other receptors. Impacts due to decommissioning works are expected to be of a similar magnitude as those observed in the construction phase.

##### Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

##### Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be **low adverse** in line with the Proposed Development alone.

#### Significance of effect

Overall, the magnitude of the cumulative impact is low in line with the Proposed Development alone**,** and the sensitivity of the receptors are low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.2 Changes to seabed morphology due to sand wave clearance and cable protection measures

### 6.13.2.1 Construction phase

#### Sensitivity of receptor

The zone of influence of the prepared works encompasses a sand wave field to the south of the Douglas OP, along the cable path. The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport which is to the east and are characterised by gradual east ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sand wave movement is also evident in Figure 6.3 and Figure 6.4. The loss to the coastal feature identified is localised and sediment displaced is expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material, furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

West Hoyle Bank is an area of shallow water creating rougher areas of wave stress, shifting sand creating sandbanks. The site is of high value given the local importance of the bank to physical processes as it acts as a natural breakwater. A natural channel currently exists within the sand bank suitable for the laying of cable, intersecting from the north to south, however a worst-case scenario would see a channel dredged through the bank. The changes to seabed morphology are localised and composed of native material, furthermore as an active sand bank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Magnitude of impact

In order to prepare the seabed for the laying of cable, a number of seabed features require partial clearance. This includes the use of a mass flow excavator to create corridors through two sections of sand waves south of Douglas OP, the material suspended is however expected to settle in the direct vicinity of works, thus providing available sediment for sand wave regeneration and minimising the impact to the sand wave field. A larger scale operation may be required across West Hoyle Bank to facilitate the pre-lay of cable, which poses a greater obstacle to the POA to Douglas OP cable. This operation requires that a dredged channel be cut through the bank, displacing a greater volume of the sand bank. However, the displaced sediment would be deposited in the vicinity of the dredged channel, with a recommendation that it be placed on the western face to allow a natural infilling of the channel with the region's sediment transport regime, which propagates in a west to east direction. Given the ready supply of sediment in the direct vicinity of works, for both regeneration of sand waves, and the infilling of the dredged sand bank, added with the mobile and dynamic nature of sediment transport in Liverpool Bay, the changes to seabed morphology arising from seabed preparation has been assessed as low for the Proposed Development alone,

#### Tier 1

The construction phase of the Proposed Development is expected to coincide with the proposed development of Awel y Môr Offshore Wind Farm. The Awel y Môr Offshore Wind Farm will have impacts on seabed morphology and coastal processes within the physical processes study area through the introduction of project infrastructure and seabed preparation activities. As the project infrastructure is introduced the impact to seabed morphology will gradually increase and therefore is best considered within the operation and maintenance phase wherein all infrastructure is in place (see Section 6.13.2.2). The seabed preparation activities associated with Awel y Môr require the sand wave clearance of array cables, export cables, the interlink cable with Gwynt y Môr and turbine/platform foundation installation via dredging techniques. These dredging operations will focus on the levelling of sand waves, therefore the change in water depths associated with the operation, considering the highly mobile migratory nature of the sand waves in the area, will not represent a change greater than the area's natural variability. Despite the sand wave clearance operations being of a larger scale to the Proposed Development, impacts to seabed morphology are again expected to be temporary and localised, with sediment returning to the areas sediment transport regime and allowing for bedform regeneration. Significant distances separate the works of the Proposed Development and Awel y Môr, with *c*. 5 km between the sand wave clearance activities of the Proposed Development and the clearance activities for the array cable (7,600,000 $m^3$), foundation installation (500,000 $m^3$), and *c.* 3 km between the dredged route through West Hoyle Bank and the sand wave clearance associated with export and interlink cabling (7,600,000 $m^3$). Based on the locality of impacts to seafloor morphology and the distance between changes arising from the operations, it can be expected that no cumulative impact between the two developments during the construction phase will arise.

In the case of Colwyn Bay, beach recharging/nourishment represents a geomorphological change to the coastline and can be expected to have minor impact on seabed morphology. No cumulative impact is expected to arise here as these changes are highly localised and the site is located *c*. 25 km from the nearest change to seabed morphology arising from the Proposed Development.

The construction phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. This is a development within the Dee Estuary, involving the construction of a 360 m length of new quay wall, the infilling of a 3.5 ha area behind the new quay wall (requiring *c*. 600,000 $m^3$ of infill material, 500,000 $m^3$ of which will be sourced from dredging activity arisings). Alongside the new quay wall a dredged berth pocket will be required to a depth of -11 m CD (*c*. 400,000 $m^3$), whilst re-dredging of the existing berth pocket along the existing quay wall to – 9 m CD will be required (*c*. 400,000 $m^3$). The largest dredging operation will take the form of the re-dredging of the main navigation channel to a depth of – 4 m CD (*c*. 3 million $m^3$). The operation and maintenance phase will again involve dredging activities of the new and existing berths, harbour, and approach channel (*c*. 499,995 $m^3$), and the disposal of resulting dredged material in the existing disposal sites. Both seabed preparation and infrastructure installation will have an impact upon seabed morphology within the Dee Estuary. As project infrastructure is introduced the impact to seabed morphology will gradually increase and therefore is best considered within the operation and maintenance phase wherein all infrastructure is in place (see Section 6.13.2.2).

Seabed preparation activities predominantly take the form of dredging as described above. The result of these activities on seabed morphology and linked physical processes, was assessed through a modelling study as part of the project application (ABPmer, 2022c), the outcome of which suggested impacts would be highly localised, with changes in flow speed as a result works limited in extent to the dredging location itself and are generally around ±20 to 50 % of baseline flow speeds.  As is currently the practice, disposal activity will be targeted to the deeper areas within the site, ensuring that bed level changes are not excessive in any one area, thus minimising the overall change. As a result, associated changes to the local seabed morphology (and sediment transport pathways) will be negligible and no cumulative impact with the Proposed Development will arise. The impact relating to operation and maintenance activities from the Mostyn Energy Park Extension is expected to be of a similar magnitude to the dredging/ disposal activities described above, only of a smaller scale in line with reduced dredge volumes associated with maintenance works as opposed to capital dredging, therefore it can be considered that no cumulative impacts on seabed morphology will arise.

The Proposed Development's construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell there will be changes to seabed morphology within the extraction site. However, it is not expected that these changes would result in a cumulative change with the sand wave clearance activities South of Douglas OP or the dredging operation through West Hoyle Bank, as a distance of *c.* 6km separates both sites from Hilbre Swash. This is supported by the extraction operations Coastal Impact Study (NRW, 2013), which found that although changes to seabed morphology may occur, impacts from the operation would be localised to the extraction site.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable repair and reburial, should the need arise. The Burbo Bank Extension is found in close proximity to the physical processes study area. Changes to seabed morphology during the reburial events may arise dependant on the presence of seabed features such as sand waves, however as with the activities for the Proposed Development itself, any change to seabed features would be both limited in magnitude and highly localised, it can therefore be considered that no cumulative impact will arise.

During the construction phase of the Proposed Development the Mares Connect cable will be in construction which may result in changes to seabed morphology. It is likely that sand wave clearance activities will be required along the Mares Connect cable route, however the location and extent of these works is currently not confirmed. It can however be expected that these works will carry a similar magnitude of impact as the Proposed Development with changes to seabed morphology remaining highly localised and of a temporary nature. Given the localised nature of changes to seabed morphology and the distance separating the Mares Connect cable from the clearance activities associated with the Proposed Development (*c*. 3 km from the dredged channel at West Hoyle Bank) no cumulative impact is expected to arise.

The construction phase of the Proposed Development coincides with suction bucket trials aiming to inform the detailed design of foundations for the Mona Offshore Wind Farm. The impact of these foundations on seabed morphology and physical processes would be highly dependent on both the parameters and locations tested. However, given the small scale nature of the trials which involve installing one foundation and removing it before moving to the next trial location to repeat, mean that impacts to seabed morphology will be intermittent and short term, with no long term effect on physical processes. Given the highly localised impact to seabed morphology associated with these trials, it is not expected that a cumulative impact with the Proposed Development will arise.

**Tier 2**

The construction phase of the Tier 2 development Mona Offshore Wind Project coincides with that off the Proposed Development. Seabed preparation activities defined by the MDS for the Mona Offshore Wind Project, requires sand wave clearance for turbines, offshore platforms, export cables, array cables, and interconnector cables. Despite a significant volume of material being cleared from the seafloor in the array area, wherein the largest clearance operation relates to the inter-array cables (9,542,806 $m^3$), it is located *c*. 10 km from the sand wave clearance operation South of Douglas OP. Sediment is also expected to be deposited in the direct vicinity of the clearance operations, giving rise to a localised impact to highly recoverable seabed features. Given the impacts from both developments are locally limited and separated by a considerable distance, no cumulative effect is anticipated to arise.

#### Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, in line with the Proposed Development alone. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.2.2 Operation and maintenance phase

### Sensitivity of receptor

Locations of the cable protection for the proposed development vary in water depths and seabed morphology. Largely these locations fall in depth ranges wherein the bed level change due to the addition of cable crossings with a maximum height of 0.8 m, will lie within the natural variability of water depths in the area, given the dynamic nature of seabed features such as sand waves and mega ripples within Liverpool Bay. The sensitivity of coastal features in these areas are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Magnitude of impact

The only cable protection measures to be utilised by the Proposed Development occur in the form of cable crossings as the nature of the seabed sediment accommodates cable burial to the required depth. In total up to 32 cable crossings may be required, 10 of which relate to the POA to Douglas OP Cable, eight for the Douglas to Hamilton Inter-OP cable, eight for the Douglas to Hamilton North Inter-OP cable, and six for the Douglas to Lennox Inter-OP cable. Depending on the heights of such cable crossings, and the depth of water they are located in, there can be potential for changes to tide, wave and sediment transport processes due to a changed seabed morphology through altered bed levels. In this case however cable crossings will be up to a maximum height of up to 0.8 m, with widths of 7 m and tapered profiles to reduce the impacts to physical processes and seabed morphology. The cable crossings will be required in a range of depths from c. 5.8 m to c. 30.3 m (CD).

This includes the POA to Douglas OP cable crossing with the Burbo Bank Offshore Wind Farm Extension Export Cable, and further offshore POA to Douglas OP cable crossing with the Western HDVC Link Transmission Cable. As outlined in section 0, the impact due to cable crossings is considered to be of local spatial extent, long term duration, continuous and of high reversibility. Given the small scale of cable crossings to be implemented and further mitigating measures such as tapered profiles and compliance with the MCA navigation guidance, it is not expected that impacts from cable crossings would be sufficient to disrupt offshore bank morphological processes, experience significant secondary scour or destabilise coastal features, the magnitude of impact is therefore considered to be negligible for the Proposed Development alone.

### Tier 1

The operation and maintenance phase of the Proposed Development is expected to coincide with the construction and operation and maintenance phases of the Awel y Môr Offshore Wind Farm. The Awel y Môr Offshore Wind Farm will have impacts on seabed morphology and coastal processes within the physical processes study area through the introduction of project infrastructure and prior seabed preparation. It was assessed for the construction phase of the Proposed Development that no cumulative impact due to seabed preparation and sand wave clearance activities during the development of both projects would arise. This due to the scale of works and locality of impacts. Again, given the changes experienced in seabed morphology and physical processes due to presence of cable crossings (which are expected to be limited to the direct vicinity of crossings), no cumulative impact due to construction activities of the Awel y Môr and operation and maintenance of the Proposed Development is expected. Likewise, no cumulative is expected to arise with the overlap in operation and maintenance phases of the two projects. With changes to seabed morphology being highly local, and physical processes such as tidal flows and sediment transport limited to within 1 km of the Awel y Môr Array Area. Therefore, it is not expected that impacts from the presence of Awel y Môr project infrastructure will accumulate with the highly local changes to seabed morphology due to the presence of cable crossings under the scope of the Proposed Development.

The operation and maintenance phase of the Proposed Development is expected to coincide with the operation and maintenance phases of the Mostyn Energy Park Extension (MEPE) and associated maintenance dredging activities. The impact relating to operation and maintenance activities from the Mostyn Energy Park Extension is expected to be of a similar magnitude to the dredging/ disposal activities for the construction phase, only of a smaller scale in line with reduced dredging volumes associated with maintenance works as opposed to capital dredging works. This paired with the even more localised changes expected from the presence of cable crossings associated with the Proposed Development suggests that no cumulative change to seabed morphology will arise.

The Proposed Development’s construction phase coincides with the operation of the Hilbre Swash aggregate extraction site situated *c*.3 km from the PoA to Douglas OP cable installation route. Given the nature of the project as an extraction operation where sediment is being removed from the cell there will be changes to seabed morphology within the extraction site. However, it is not expected that these impacts would result in a cumulative impact with the changes in seabed morphology caused by the Proposed Developments cable crossings, the closest of which is as a distance of *c.* 5 km from Hilbre Swash. This is supported by the extraction operations Coastal Impact Study (NRW, 2013), which found that although changes to seabed morphology may occur, impacts from the operation would be localised to the extraction site.

The Burbo Bank Extension Offshore Wind Farm, a project which has obtained a license for emergency cable repair and reburial, should the need arise, is found in close proximity to the physical processes study area. Changes to seabed morphology during the reburial events may arise dependant on the presence of seabed features such as sand waves, however as with the activities for the Proposed Development itself, any change to seabed features would be both limited in magnitude and highly localised, it can therefore be considered that no cumulative impact will arise.

During the operation and maintenance phase of the Proposed Development the Mares Connect cable will be in operation which may result changes to seabed morphology. It is likely that maintenance activities such as cable repair and reburial will be required along the Mares Connect cable route, however the location and extent of these works is currently not confirmed. It can however be expected that these works may carry a similar magnitude of impact as the sand wave clearance activities discussed for the construction phase of the Proposed Development with changes to seabed morphology remaining highly localised and of a temporary nature. Given the intersection with the Mares Connect cable is one of the anticipated cable crossings for the Proposed Development, a cumulative impact may arise if maintenance works are required in the vicinity of the cable crossing. However, this cumulative effect would be of negligible magnitude and limited spatially.

#### Tier 2

The cumulative impact assessment considers the construction, and operation and maintenance phases of Mona Offshore Wind Farm coinciding with the operation and maintenance phase of Proposed Development. It was assessed for the construction phase of the Proposed Development that no cumulative impact due to seabed preparation and sand wave clearance activities during the development of both projects would arise. This due to the scale of works and locality of impacts. Again, given the changes experienced in seabed morphology and physical processes due to presence of cable crossings (which are expected to be limited to the direct vicinity of crossings), no cumulative impact due to construction activities of the Mona Offshore Wind Farm and operation and maintenance of the Proposed Development is expected. The operation and maintenance phase of the Mona Offshore Wind Farm also coincides with the operation and maintenance phase of the Proposed Development and will have an impact on seabed morphology and physical processes. However, it can be understood from the Mona Offshore Wind Farm Technical Report (RPS, 2022), that changes caused by the addition of project infrastructure to the water column and seabed will have largely localised impacts to physical processes, with changes to tidal currents and sediment transport being limited to the immediate vicinity of installations. This paired with the fact the Mona Array Area is located *c.* 9 km from the Proposed Development and the highly localised changes expected from the presence of cable crossings associated with the Proposed Development, means it can be expected that no cumulative effect will arise.

### Cumulative effect

The cumulative effect is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, in line with the Proposed Development alone. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.2.3 Decommissioning phase

### Sensitivity of receptor

The sand waves within Liverpool Bay have a highly mobile and dynamic nature. Sand wave features are predominately aligned perpendicular to the net sediment transport, which is to the east, and they are characterised by gradual east–ward migration (ABPmer, 2023b), as supported by a number of sediment transport studies in the region (Kenyon and Cooper, 2005; ABPmer, 2022a; ABPmer, 2022b). The direction of sand wave movement is also evident in Figure 6.3. The alteration of coastal features from decommissioning activities much like the construction phase would be localised and sediment displaced expected to be deposited in the immediate vicinity of the sand wave features, providing material for sand wave regeneration. This deposition would be composed of the native material furthermore as active seabed features the sand waves are characterised by sediment redistribution, therefore the structure and function of the coastal feature are of low vulnerability and highly recoverable. The sensitivity of the receptor is therefore considered to be low.

A worst-case scenario would see a channel similar to that created in the construction phase, dredged through the bank. The changes to seabed morphology would again be localised and composed of native material, furthermore as an active sand bank the site is characterised by sediment redistribution and therefore the structure and function of the features are of low vulnerability and recoverable. The sensitivity of the receptor is therefore considered to be low.

### Magnitude of impact

The magnitude of the increase in suspended sediment concentrations arising from decommissioning activities during the decommissioning phase, has been assessed as low for the Proposed Development alone, as described in section 6.11.1. Decommissioning activities will involve the removal of all project infrastructure and equipment for disposal onshore. Impacts due to decommissioning works are expected to be of a similar magnitude as those observed in the construction phase.

#### Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

#### Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be low adverse in line with the Proposed Development alone.

### Significance of effect

Overall, the magnitude of the cumulative impact is low in line with the Proposed Development alone, and the sensitivity of the receptors are low. The cumulative effect will, therefore, be of **minor adverse** significance, which is **not significant**.

## 6.13.3 Activities affecting surrounding water quality

### 6.13.3.1 Construction phase

#### Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

#### Magnitude of impact

##### Tier 1 and Tier 2

There were nine Tier 1 projects and one Tier 2 project identified with the potential to result in cumulative effects surrounding changes in water quality (Table 6.16). As above for the assessment of the Proposed Development alone (section 6.11.3), increased SSCs and associated deposition is the main vector for impacts to water quality. This has been cumulatively assessed already in section 6.13.1.1, and is not repeated here for brevity. The cumulative effect of increased SSCs and associated deposition for Tier 1 and Tier 2 projects is considered to be low.

Water quality could also be cumulatively impacted by accidental pollution from vessels associated with the Tier 2 and Tier 3 projects. However, as per the Proposed Development, the Tier 1 and Tier 2 projects are also expected to comply with MARPOL regulations and have embedded mitigation similar to that of the Proposed Development (e.g. an EMP, which includes a MPCP).

#### Cumulative effect

Overall, the cumulative effect of impacts to surrounding water quality is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

## 6.13.3.2 Operation and maintenance phase

### Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

### Magnitude of impact

#### Tier 1 and Tier 2

There were five Tier 1 and one Tier 2 projects identified with the potential to result in cumulative effects surrounding changes in water quality (Table 6.16). As above for the assessment of the Proposed Development alone (section 6.11.3), increased SSCs and associated deposition is the main vector for impacts to water quality. This has been cumulatively assessed already in section 6.13.1.2, and is not repeated here for brevity. The cumulative effect of increased SSCs and associated deposition for Tier 1 and Tier 2 projects is considered to be low.

Water quality could also be cumulatively impacted by accidental pollution from vessels associated with the Tier 1 and Tier 2 projects. However, as per the Proposed Development, the Tier 1 and Tier 2 projects are also expected to comply with MARPOL regulations and have embedded mitigation similar to that of the Proposed Development (e.g. an EMP, which includes a MPCP).

Water quality may cumulatively be impacted by changes to seabed morphology in the subtidal environment due to cable protection measures, through secondary scour. This has been cumulatively assessed with regard to the changes in seabed morphology and potential for secondary scour in section 6.13.2.2, and is not repeated here. The cumulative effect of changes to seabed morphology due to sand wave clearance and cable protection measures for Tier 1 and Tier 2 projects is considered to be low.

#### Cumulative effect

Overall, the cumulative effect of impacts to surrounding water quality due to increased SSCs and associated resuspension of sediment contaminants and accidental pollution is predicted to be of local spatial extent, short-term duration, intermittent and of high reversibility, with potential impacts to the Dee Estuary SAC/SPA/SSSI and West Hoyle Bank. The magnitude is, therefore, considered to be low adverse.

The cumulative effect of impacts to surrounding water quality due to changes to seabed morphology due to cable protection measures is predicted to be of local spatial extent, long term duration, permanent during the operation and maintenance phase and of high reversibility. As described for the project alone, given the small scale of cable crossings to be implemented, it is not expected that impacts from cable crossings would be sufficient to experience significant secondary scour. The magnitude is, therefore, considered to be low adverse.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

### 6.13.3.3 Decommissioning phase

### Sensitivity of receptor

The sensitivity of the receptor is as described above for the assessment of the Proposed Development alone (see section 6.11.3). All receptors are deemed to be of high vulnerability and low recoverability, and the sensitivity is considered to be high.

### Magnitude of impact

#### Tier 1

No overlap with the Proposed Developments decommissioning activities and Tier 1 construction, operation and maintenance, or decommissioning phases is anticipated, therefore there is no pathway for a cumulative change in water quality.

#### Tier 2

The decommissioning phase of the Proposed development overlaps with the operation and maintenance phase of the Mona Offshore Wind Project. The magnitude of cumulative impacts is expected to be the same as those described for the Tier 2 project in the operation and maintenance phase, i.e. similar activities to the construction phase but of reduced scale and magnitude, combined with those of the magnitude of the construction phase for the proposed development. It can therefore be assumed for the same reasons as the construction phase, that no cumulative change will arise with the Mona Offshore Wind Project.

#### Cumulative effect

No cumulative effect is expected during the decommissioning phase. The magnitude is, therefore, considered to be low adverse in line with the Proposed Development alone.

### Significance of effect

Overall, the magnitude of the cumulative impact is low, and the sensitivity of the receptor is high. As per Table 6.13, this yields a minor or moderate significance. The cumulative effect will, be of **minor adverse** significance due to the embedded mitigation measures adopted to minimise the effects of this impact, such as development and adherence to an EMP (including a MPCP), which sets out pollution prevention methods and the requirement for all vessels to comply with the MARPOL regulations.

## 6.14 Transboundary effects

A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regard to physical processes from the Proposed Development upon the interests of other states.

## 6.15 Inter-related effects

Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the Proposed Development (construction, operation and maintenance, and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three phases.
- Receptor led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. As an example, all effects on physical processes, such as sediment plumes, may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short term, temporary or transient effects, or incorporate longer term effects.

A description of the likely interactive effects arising from the Proposed Development on the physical processes receptors is provided in section volume 2, chapter 14.

## 6.16 Conclusion

Information on physical processes within the physical processes study area was collected through detailed desktop review of existing studies and datasets and supported by numerical modelling.

Table 6.17 presents a summary of the potential impacts, measures adopted as part of the Proposed Development and residual effects in respect physical processes. The impacts assessed include:

- increased SSCs and sediment deposition;
- changes to seabed morphology; and
- activities affecting surrounding water quality.

Overall, it is concluded that there will be no significant effects arising from the Proposed Development during the construction, operational and maintenance or decommissioning phases as all impacts have a significance level of minor or less.

Table 6.18 presents a summary of the potential cumulative impacts, mitigation measures and residual effects. The cumulative impacts assessed include:

- increased SSCs and sediment deposition
- changes to seabed morphology; and
- activities affecting surrounding water quality.

Overall, it is concluded that there will be no significant cumulative effects from the Proposed Development alongside other projects/plans, as all impacts have a significance level of minor or less.

No potential transboundary impacts have been identified regarding effects of the Proposed Development.

**Table 6.17: Summary of Potential Environmental Effects, Mitigation and Monitoring.**

| Description of Impact | Phase[a] C | Phase[a] O | Phase[a] D | Magnitude of Impact | Sensitivity of the Receptor | Significance of Effect | Further Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|---|---|
| Increased suspended sediment concentrations (SSCs) and sediment deposition. | ✓ | ✓ | ✓ | C: Low<br>O: Low<br>D: Low | C: Low<br>O: Low<br>D: Low | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>D: Minor adverse (not significant) | N/A | N/A | N/A |
| Changes to seabed morphology due to sand wave clearance and cable protection measures | ✓ | ✓ | ✓ | C: Low<br>O: Negligible<br>D: Low | C: Low<br>O: Low<br>D: Low | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>O: Minor adverse (not significant) | N/A | N/A | N/A |
| Activities affecting surrounding water quality | ✓ | ✓ | ✓ | C: Low<br>O: Negligible to low<br>D: Low | C: High<br>O: High<br>D: High | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>D: Minor adverse (not significant) | N/A | N/A | N/A |

[a] C=construction, O=operation and maintenance, D=decommissioning

**Table 6.18: Summary of Potential Cumulative Environmental Effects, Mitigation and Monitoring.**

| Description of Impact | Phase[a] C | O | D | Magnitude of Impact | Sensitivity of the Receptor | Significance of Effect | Further Mitigation | Residual Effect | Proposed Monitoring |
|---|---|---|---|---|---|---|---|---|---|
| Increased suspended sediment concentrations (SSCs) and sediment deposition. | ✓ | ✓ | ✓ | C: Low<br>O: Low<br>D: Low | C: Low<br>O: Low<br>D: Low | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>D: Minor adverse (not significant) | N/A | N/A | N/A |
| Changes to seabed morphology due to sand wave clearance and cable protection measures | ✓ | ✓ | ✓ | C: Low<br>O: Low<br>D: Low | C: Low<br>O: Low<br>D: Low | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>O: Minor adverse (not significant) | N/A | N/A | N/A |
| Activities affecting surrounding water quality | ✓ | ✓ | ✓ | C: Low<br>O: Low<br>D: Low | C: Low<br>O: Low<br>D: Low | C: Minor adverse (not significant)<br>O: Minor adverse (not significant)<br>D: Minor adverse (not significant) | N/A | N/A | N/A |

* C=construction, O=operation and maintenance, D=decommissioning

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