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14. Marine Ecology and Nature Conservation

14.1 Introduction

14.1.1 This chapter of the Environmental Statement (ES) identifies the potential impacts and effects to marine ecology and nature conservation that are considered as part of the Environmental Impact Assessment (EIA) of the Proposed Development. A detailed description of the Proposed Development can be found within Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2).

14.1.2 The Site boundary is shown on Figure 3-1: Site Boundary Plan (ES Volume II, Document Ref. 6.3).

14.1.3 The elements of the Proposed Development which are of primary relevance to this chapter broadly include:

- Construction phase:
  - construction of the Water Discharge Connections including the replacement outfall if required;
  - construction of the CO_2 Gathering Network;
  - construction of the Natural Gas Corridor; and
  - construction of the onshore CO_2 Export Pipeline.
- Operational phase (including maintenance):
  - air emissions;
  - treated water discharge to the Tees Bay; and
  - routine operational and maintenance ("O&M") activities associated with the continued safe and efficient operation of the Proposed Development[1].
- Decommissioning phase:
  - removal of all above ground infrastructure; and
  - buried pipelines to be left *in situ*.

14.1.4 This chapter sets out a review of the existing marine ecological baseline conditions and assesses the potential temporary and permanent impacts of the Proposed Development. The marine ecological receptors that are considered in this chapter are:

- designated sites;
- plankton (phytoplankton and zooplankton);

[1] O&M activities are included within the scope of the Draft Deemed Marine Licence (Document Ref. 5.1) and will be subject to appropriate conditions drafted and agreed with the Marine Management Organisation.

- benthic ecology (including invasive non-native species (INNS));
- fish and shellfish (including migratory fish species);
- commercial fisheries; and
- marine mammals.

14.1.5 For the purposes of this assessment, the marine environment is defined as any area seaward of the mean high-water springs (MHWS) mark of any tidally influenced water body. Thus, it includes intertidal zones, which are periodically exposed by the tide and subtidal zones which are always submerged. It is acknowledged that for the purposes of marine consenting, the UK Marine Area (Section 42, Marine and Coastal Access Act 2009) does also include areas which are temporarily or permanently separated from the natural course of the tide (i.e. by a lock gate or other similar means).

14.1.6 Terrestrial designations, habitats, and species, i.e. those above MHWS, are considered in Chapter 12: Terrestrial Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2) whilst freshwater ecological baseline conditions and assessments are reported within Chapter 13: Aquatic Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2). Impact pathways to coastal seabirds and associated designated sites are considered in Chapter 15: Ornithology (ES Volume I, Document Ref. 6.2), whilst marine water quality has also been considered within Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

14.1.7 This chapter is supported by the following technical appendices, provided in ES Volume III Document Ref. 6.4):

- Appendix 12B: Ecological Impact Assessment Methodology
- Appendix 14A: Intertidal Benthic Ecology Survey Report
- Appendix 14B: Fisheries and Fish Ecology Baseline Report
- Appendix 14C: Marine Mammal Ecology Baseline Report
- Appendix 14D: Subtidal Benthic Ecology Survey Report
- Appendix 14E: Coastal Modelling Report

14.1.8 This chapter also refers to the Habitat Regulations Assessment Report (Document Ref. 5.13) submitted with the Application.

14.2 Legislation and Planning Policy Context

14.2.1 The assessment included within this ES Chapter has been undertaken within the context of relevant planning policies (both national and local), guidance documents and legislative instruments, the background for which has been detailed within Appendix 12A: Legislation and Planning Policy Relevant to Ecology and Nature Conservation (ES Volume III, Document Ref. 6.4). A summary of the legislative background and policies relating to marine ecology and nature conservation is provided below.

Legislative Background

14.2.2 The following legislation is considered relevant to the Proposed Development in respect of marine ecology:

- The Conservation of Habitats and Species Regulations 2017 (as amended) (the Habitats Regulation);
- The Water Environment (Water Framework Directive (WFD)) (England and Wales) Regulations 2017;
- Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000);
- The Natural Environment and Rural Communities Act (NERC Act) 2006;
- The Marine and Coastal Access Act 2009;
- Conservation of Seals Act 1970 (as amended by the Conservation of Seals (England) Order 1999);
- Salmon and Freshwater Fisheries Act 1975 (as amended);
- The Eels (England and Wales) Regulations 2009;
- Environmental Protection Act 1990; and
- Invasive Alien Species (Enforcement and Permitting) Order 2019.

National Policy

14.2.3 The key national planning policy related to the Proposed Development in respect of marine ecology includes:

- Overarching National Policy Statement for Energy (EN-1) (Department of Energy and Climate Change (DECC), 2011a);
- National Policy Statement for Fossil Fuel Electricity Generating Infrastructure (EN-2) (DECC, 2011b);
- National Planning Policy Framework ((Ministry of Housing, Communities and Local Government (MHCLG), 2019));
- Governments' 25-Year Environmental Plan (HM Government, 2018);
- The UK Marine Policy Statement (HM Government, 2011); and
- UK Biodiversity Action Plan (1994 – 2012) (HM Government, 1994).

14.2.4 The overarching National Policy Statement for Energy (NPS EN-1) (DECC, 2011a) sets out national policy for energy infrastructure. Part 5.3 relates to biodiversity and requires that the applicant shows how the project adheres to the Government's biodiversity strategy which aims to ensure:

- "*A halting, and if possible a reversal, of declines in priority habitats and species, with wild species and habitats as part of healthy, functioning ecosystems; and*
- *The general acceptance of biodiversity's essential role in enhancing the quality of life, with its conservation becoming a natural consideration in*

all relevant public, private and non-governmental decisions and policies" (paragraph 5.3.5 of NPS EN-1)."

14.2.5 It also states the following in relation to the impact of a development on biodiversity:

- "*As a general principle, and subject to the specific policies below, development should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives; where significant harm cannot be avoided, then appropriate compensation measures should be sought" (NPS EN-1 paragraph 5.3.7*); and
- "*In taking decisions, the IPC should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment*" (NPS EN-1 paragraph 5.3.8).

14.2.6 Adherence to these policies must be demonstrated through robust application of the mitigation hierarchy and (as set out in paragraph 5.3.18 of NPS EN-1) can achieved by the application of appropriate mitigation to ensure that:

- The footprint of construction activities is reduced as far as practicable;
- Construction and operation best practice is adhered to in order to minimise disturbance to marine habitats and species;
- Restoration of habitats is carried out where loss and physical disturbance cannot be avoided; and
- Opportunities are sought to conserve and enhance biodiversity.

14.2.7 Where appropriate mitigation cannot be applied, it would be expected that requirements would be attached to the Development Consent Order (DCO) consent and / or any planning obligations entered into.

14.2.8 Also of relevance to marine ecology is part 5.15 of NPS EN-1 which relates to water quality and resources and requires applicants to consider impacts of the Proposed Development to water bodies and protected areas (e.g. shellfish waters) under the WFD.

14.2.9 Taken in conjunction with the NPS EN-1, the National Planning Policy for Fossil Fuel Electricity Generating Infrastructure (NPS EN-2) (DECC, 2011b) provides the primary basis for decisions by the Secretary of State (SoS) on applications it receives for nationally significant fossil fuel electricity generating stations. Part 2.10 of NPS EN-2, which is of relevance to marine ecology, states that an applicant should undertake an assessment of likely effects on water quality and resources of the Proposed Development (as required in NPS EN-1). In particular, this assessment should demonstrate that appropriate measures will be put in place to avoid or minimise adverse impacts of abstraction and discharge of cooling water. In addition to the mitigation measures set out in NPS EN-1, the design of the cooling system should include intake and outfall locations that avoid and minimise adverse impacts. Further mitigation measures should be specific to minimise fish impingement

and/or entrainment and to prevent excessive heat from discharges to receiving waters.

14.2.10 Planning policy to support the halting of overall declines in biodiversity is set out in the National Planning Policy Framework (NPPF) (Housing, Communities and Local Government, 2019) and the Governments' 25-Year Environment Plan (HM Government, 2018). Both policy documents also include a commitment to promote opportunities to incorporate biodiversity improvements in order to achieve net gains for biodiversity.

14.2.11 Whilst the NPPF does not directly apply to nationally significant infrastructure projects (NSIPs), such as the Proposed Development, the SoS may have regard to policies in the NPPF if the SoS thinks that they are important and relevant.

14.2.12 The Governments' 25-Year Environment Plan, which aligns with the Clean Growth Strategy, is relevant to the Proposed Development. The Environment Bill, expected to be passed into law in 2021, sets out to achieve the commitments outlined in the Governments' 25-Year Environment Plan, and mandates biodiversity net gain for development (housing and commercial), although this does not currently apply to NSIPs. To fulfil the aims of the 25-Year Environment Plan and the upcoming Environment Bill, Natural England has developed 'Defra [Department for Environment, Food and Rural Affairs] Metric 2.0', a tool for measuring and accounting for biodiversity losses and gains resulting from development. The latest version of this tool, which was published in December 2019, includes intertidal habitats[2]. The ES has examined biodiversity losses and gains of benthic habitats in relation to the Proposed Development, ensuring that overall biodiversity net loss would be offset (see paragraphs 14.6.22 to 14.6.24). However, a formal Biodiversity Assessment (using Natural England's 'Defra Metric 2.0' tool[2]) was not undertaken, as it is anticipated that there will be no permanent benthic habitat loss in the intertidal zone.

14.2.13 The UK Marine Policy Statement (MPS) provides a framework for preparing marine plans and taking decisions affecting the marine environment. Its focus is on promoting sustainable economic development with respect to the marine environment, ensuring promotion of healthy, functioning marine ecosystems and protecting marine habitats, species and heritage assets. As the North East Inshore Marine Plan is still under development, the MPS remains the relevant policy document - NSIP applications are required to have regard to the MPS.

14.2.14 Once the North East Marine Plan has been formally published, and notification is provided that it is the relevant policy document under Section 59 of the Marine and Coastal Access Act (2009), it will become a formal consideration as part of the NSIP decision process. A draft of the North East Marine Plan was published for consultation in January 2020. At the time of writing the plan is yet to be adopted meaning the ES will demonstrate compliance with the MPS, being the relevant policy document at the time of its publication. Based on the current content of the draft North East Marine Plan, the ES is considered to be compliant with the broad scope of these plan policies.

[2] http://publications.naturalengland.org.uk/publication/5850908674228224

However, depending on the status of the Marine Plan at the point of submission, it may be considered as important and relevant by the SoS .

14.2.15 The UK Biodiversity Action Plan (BAP) was published in 1994 and was the UK Government's response to the Convention on Biological Diversity (CBD). Action plans for the most threatened species and habitats were set out to aid recovery, and national reports, produced every three to five years, showed how the UK BAP was contributing to the UK's progress towards the significant reduction of biodiversity loss called for by the CBD. The UK BAP priority list contained 1,150 species and 65 habitats requiring special protection.

14.2.16 The 'UK Post-2010 Biodiversity Framework', published in July 2012, succeeds the UK BAP. This is the result of a change in strategic thinking following the publication of the CBD's 'Strategic Plan for Biodiversity 2011–2020' and its 20 'Aichi Biodiversity Targets', agreed at Nagoya, Japan in October 2010, and the launch of the new EU Biodiversity Strategy 2020 in May 2011. The lists of species and habitats of principal importance listed under Section 41 of the NERC Act 2006 forms the basis of much biodiversity work in each of the devolved administrations.

Local Policy

14.2.17 The land considered for the Proposed Development is located within the administrative boundaries of Redcar & Cleveland Borough Council (RCBC) and Stockton-on-Tees Borough Council (STBC). Local planning policy relevant to this ES Chapter is set out in the Redcar & Cleveland Local Plan (adopted in May 2018) (RCBC, 2018) and the Stockton-on-Tees Local Plan (adopted in January 2019) (STBC, 2019).

14.2.18 Policy N1 (Landscape) and N4 (Biodiversity and Geological Conservation) of the Redcar & Cleveland Local Plan relates to the protection of the marine environment and important sites for biodiversity including Special Protection Areas (SPAs) / Ramsar, European Marine Sites, Sites of Special Scientific Interest (SSSI) and local nature reserves (RCBC, 2018). Similar themes are covered by the Stockton-on-Tees Local Plan Policy ENV5 which aims to preserve, protect and enhance ecological networks, biodiversity and geodiversity (STBC, 2019).

14.2.19 Both local plans make specific mention of the then proposed extension of the Teesmouth and Cleveland Coast SPA into the marine environment to protect breeding colonies of common tern (*Sterna hirundo*) and avocet (*Recurvirostra* spp.) as well as non-breeding waterbirds. The policies outlined above provide the necessary safeguards to protect both designated and proposed nature conservation sites.

14.2.20 The Tees Valley Biodiversity Action Plan (BAP) covers the local authority areas of Hartlepool, Stockton, Middlesbrough and Redcar and Cleveland. Darlington is currently being incorporated into the plan.

14.2.21 Local Priority Species for the Tees Valley which are relevant to the assessment of marine ecology include salmon (*Salmo salar*), sea trout (*Salmo trutta*), European eel (*Anguilla anguilla*) river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*).

14.2.22 Local Priority Habitats for the Tees Valley which are relevant to the assessment of marine ecology (with some overlap with terrestrial and aquatic ecology) include maritime cliffs and slopes, mudflats and saltmarsh, sand dunes, saline lagoons.

14.2.23 The cornerstone of the Tees Valley BAP is a series of habitat and species action plans for locally identified priority habitats and species (Tees Valley Nature Partnership, 2012). As the Tees is recognised as one of the main salmon rivers in England and Wales, there is currently a Salmon Action Plan enforced by the Environment Agency (EA) (Environment Agency, 2009a).

14.2.24 The actions of high priority within the Salmon Action Plan (SAP) include:

- to improve water quality in the lower river and estuary;
- free fish passage past the Tees Barrage;
- to improve evaluation of compliance against spawning targets;
- maintain liaison with developers to ensure impacts of new developments are minimised; and
- promote new regional byelaws relating to fishing near obstructions.

14.3 Assessment Methodology and Significance Criteria

Use of the Rochdale Envelope

14.3.1 In accordance with the Planning Inspectorate (PINS) Advice Note 9 (PINS, 2018), the ES presents a robust yet reasonable “worst-case” assessment of the impact pathways of the Proposed Development on marine ecology, using the “Rochdale Envelope” approach, applicable where a degree of flexibility needs to be maintained for certain aspects of the design.

14.3.2 For example, the existing on-site outfall to the Tees Bay is proposed for the development. The outfall may require refurbishing or alternatively replacing on a new alignment adjacent to the CO_2 Export Pipeline. As replacement represents the worst-case option, both this and refurbishment are assessed in this ES. In the event replacement is required, the replacement outfall would be constructed alongside the CO_2 Export Pipeline, using a Micro-Bored Tunnel (MBT) (conducted by a MBT machine,) from the main PCC Site to an break-out point 2 km offshore (within the marine environment of the Site boundary).

14.3.3 The section of the CO_2 Export Pipeline included in the Application will start within the PCC Site boundary at the HP Compressor Station and pass under the private road to South Gare, under Coatham Dunes and Sands to MLWS. To facilitate this, the pipeline will need to pass under parts of the Teesmouth and Cleveland Coast SPA/Ramsar and the Teesmouth and Cleveland Coast SSSI.

14.3.4 The export pipeline will be by trenchless technologies. It will be necessary to run power and a fibre-optic control cables from the PCC Site to the off-shore installation and to a remote isolation valve. These will be installed at the same time as the CO_2 Export Pipeline using separate trenchless crossings.

14.3.5 The preferred methodology is for the HDD to be drilled offshore to onshore. In this scenario, HDD would start at a location approximately 3 km offshore, outside the Site boundary, where there is a minimum water depth of 5 m, and exit onshore at the PCC Site. However, it may be necessary to adopt a worst-case scenario of HDD in the opposite direction, from onshore to offshore.

14.3.6 The offshore works associated with construction and operation of the CO_2 pipeline beyond MLWS and operation of the off-shore storage facility will be consented through a separate off-shore consent via a separate Marine Licence (ML) application to the Marine Management Organisation (MMO) supported by a separate EIA (see Section 4.8[3]). The Endurance geological storage facility will be operated under a licence from the Oil and Gas Authority (OGA) and regulated by the OGA under a storage permit.

14.3.7 Environmental effects from the construction and operation of the off-shore elements of the Project are considered in Appendix 24C: Statement of Combined Effects (ES Volume III, Document Ref. 6.4) and in the cumulative impact assessment in this ES for the Proposed Development as presented in Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2). The combined effects on marine ecology and nature conservation for the offshore elements of the CO_2 Export Pipeline (below MLWS) have been considered within this ES Chapter (see Section 14.10).

14.3.8 Preferred and worst-case construction assumptions are shown in Table 14-1 alongside the preferred scenarios for the works. Further information can be found in Chapter 5: Construction Programme and Management (ES Volume I, Document Ref. 6.2).

Table 14-1: Preferred and Worst-Case Construction Scenarios

Construction element	Preferred scenario	Worst-case scenario assessed
Natural Gas Connection Corridor – River Tees crossing	'No dig' construction using trenchless technologies (a bored tunnel)	Same as preferred scenario
Water Supply Connection	Connection to Northumbrian Water Ltd (NWL) industrial water supply and sewerage network via existing Freshwater Connection Corridor	Same as preferred scenario
Water Discharge Connection	Use of existing outfall from former Steelworks, in Tees Bay, with minor maintenance and refurbishment works	Removal of existing outfall head and emplacement of a new outfall head and diffuser to include: – Dredging of pocket around existing outfall head – Installation of new outfall head and diffuser to include a short campaign of pin pile drilling to secure the structure – Backfill of the dredged pocket around the new outfall head

[3] Note: Land between MHWS and MLWS is covered by both the DCO and Marine Licensing regimes

Construction element	Preferred scenario	Worst-case scenario assessed
		– The positioning of rock armouring / scour protection around the new outfall head – Final assembly, pipeline jointing, connections, fabrication and ancillary commissioning works to connect to outfall head In the event that the outfall requires **replacement**, this would be installed as an MBT running from the PCC Site to the discharge point within Tees Bay (see Figure 3-2D (ES Volume II, Document Ref. 6.3) and Box 5-1). This would run parallel to the CO_2 Export Pipeline and would be carried out at the same time. The replacement outfall would also require a diffuser head to be fitted. Construction activities are anticipated to be comparable to those described above for the existing outfall. Both activities would require the presence of vessels such as dredger(s), work boat(s) and / or barge(s) as well as potential survey activities to support the refurbishment or replacement process
CO_2 Export Pipeline	Construction from approximately 3 km offshore (outside of the Site) to within the PCC Site, using trenchless technologies (by HDD)	Use of trenchless technologies (by HDD) from onshore (within the PCC Site) to approximately 3 km offshore (outside of the Site)
CO_2 Gathering Network – Tees Crossing	The CO_2 Gathering Network pipeline (and associated fibre-optic control cable) will need to cross the River Tees using trenchless technologies via either: 1. sharing the micro-bored tunnel from Navigator Terminals to the Teesworks site with the Natural Gas Connection (see above); or 2. a direct crossing from Navigator Terminals to the northern bank of the Dabholm Gut constructed using HDD techniques, with the fibre-optic control cable installed using an existing utilities tunnel under the Tees.	Same as preferred scenario

Assessment Methodology

14.3.9 All ecological impact assessments (EcIA) for the project have been completed in accordance with the Chartered Institute of Ecology and Environmental Management's (CIEEM) Guidelines for Ecological Impact Assessment in the

UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CEEM, 2019). The detailed methodology is outlined in Appendix 12B: Ecological Impact Assessment Methods (ES Volume III, Document Ref. 6.4).

14.3.10 For this chapter, the general ecological method discussed in Appendix 12B: Ecological Impact Assessment Methods has been, where appropriate, amended to reflect the specific conditions of the marine environment. In particular, the methodology has been amended to ensure that the interconnectivity of the marine environment is considered fully in light of the predicted Zone of Influence (ZoI) arising from the Proposed Development. The marine specific criteria of the assessment process are described in the following sections.

14.3.11 The aims of the ecological impact assessment (EcIA) are to:

- identify important ecological features (e.g. designated sites, habitats or species) which have the potential to be impacted by the Proposed Development;
- provide a robust assessment of the likely ecological impacts and resultant effects of the Proposed Development, which may be beneficial (i.e. positive) or adverse (i.e. negative);
- facilitate determination of the consequences of the Proposed Development in terms of national, regional and local policies relevant to nature conservation and biodiversity, where the level of detail provided is proportionate to the scale of the development and the complexity of its impact pathways;
- identify appropriate mitigation to reduce any likely ecological impacts; and
- set out the steps to be taken to adhere to legal requirements relating to the relevant ecological features concerned.

14.3.12 In accordance with CIEEM (2019) guidance, not all habitats and species which have the potential to occur in the ZoI of the Proposed Development have been considered within the EcIA. Rather, focus has been placed on those features considered to be 'important' – determining importance is discussed in further detail below. To ensure compliance with National and European policy, consideration is still given to biodiversity in its entirety and the need to achieve no net loss and enhancement of biodiversity.

14.3.13 In accordance with the appropriate guidance above, the importance of an ecological feature or receptor is defined according to the following factors:

- conservation or legal status;
- quality or health;
- extent; and
- rarity or endemism.

14.3.14 The importance of an ecological feature has been defined with reference to a specific geographical context, ensuring consistency with CIEEM (2019) guidance. Marine features are highly connected with few boundaries and therefore the levels of geographical importance must recognise this. The

levels presented below are based on the level to which the marine ecological receptor may qualify as a legislative or policy designating feature. Therefore, the approach adopts the level of legislative designation as a proxy for the geographical importance of a marine species receptor.

- international (designated Natura 2000 sites in accordance with the Habitats Directive and Birds Directive – Special Areas of Conservation (SACs), Special Protected Areas (SPAs), Ramsar Sites);
- national (UK protected areas – Sites of Special Scientific Interest (SSSI), Marine Protected Areas (MPAs), and Marine Conservation Zones (MCZs));
- regional or local (ecological features that do not meet criteria for valuation at an international or national level, but that have sufficient value to merit retention or mitigation e.g. for the purpose of ensuring no net loss of biodiversity).

14.3.15 The criteria to show how the importance of a particular ecological feature or receptor is classified are shown in Table 14-2 below.

Table 14-2: Importance Criteria for Marine Ecology Features / Receptors

Importance	Description*
Very High	Designated sites and qualifying / supporting features of international importance. Species which are legally protected and / or in significant decline (i.e. classified as 'endangered' or 'critically endangered' according to the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2019)). High quality examples of rare habitats which are threatened throughout their range.
High	Designated sites and qualifying / supporting features of national conservational importance. Priority habitats and species or those considered to be of principal importance for the conservation of biodiversity in England and those species considered vulnerable to decline (i.e. classified as 'vulnerable' or 'near threatened' according to the IUCN Red List). High quality examples of uncommon habitats which are vulnerable throughout their range.
Medium	Habitats and species of regional or local importance (i.e. Annex 1 habitats, in accordance with the Habitats Regulations, which are not a qualifying feature of a nearby designated site). Those species considered to be of 'least concern' (according to the IUCN Red List or listed in the OSPAR[4] list of threatened and / or declining species for the North-East Atlantic). Poor quality examples of rare or uncommon habitats which are threatened or vulnerable throughout their range.
Low	Habitats and species of low conservation importance, such as those generally abundant and widespread around the UK with no specific local value.

*Should there be any overlap in the description of a particular feature / receptor, the worst-case importance criteria shall be adopted.

[4] OSPAR refers to the Oslo and Paris Convention for the protection of the marine environment of the North-East Atlantic

14.3.16 In line with the CIEEM guidelines, the terminology used within the EcIA draws a clear distinction between the terms ‘impact’ and ‘effect’. For the purposes of the EcIA, these terms are defined as follows:

- impact – actions resulting in changes to an ecological feature; for example, underwater sound disturbance leading to displacement of hearing sensitive species; and
- effect – outcome resulting from an impact, acting upon the conservation status or structure and function of an ecological feature; for example, displacement of individuals and loss of important foraging or breeding grounds leading to effects on the reproduction and survival of the local population.

14.3.17 The impact significance has been based on assessing the impact magnitude (i.e. the deviation from the baseline condition) and the sensitivity and value (which is synonymous with 'importance') of the receptor. Temporary, permanent, direct and indirect impacts have been considered during the construction, operation and decommissioning phases of the Proposed Development, and any mitigation measures necessary have been identified.

14.3.18 To determine the likely significance of impact, the following parameters have been considered:

- impact type - direct or indirect, positive or negative, temporary or permanent;
- magnitude of impact – the ‘amount’ or intensity of an impact. This may sometimes be synonymous with ‘extent’ (see below) for certain receptors, such as habitats loss. For mortality it may be the number of individuals killed;
- spatial extent of impact – the area over which the impact will occur; and
- temporal nature of impact – timing, frequency and duration.

14.3.19 The assessment has also given regard to the sensitivity of an ecological feature to an impact which is determined by its:

- adaptability - i.e. the capacity, or lack thereof, of a feature to avoid or adapt to a change; and
- tolerance / resilience - i.e. capacity, or lack thereof, of a feature to accommodate temporary or permanent change or recover to pre-existing state following exposure to a change.

14.3.20 By combining the characteristics of an impact pathway with the importance and sensitivity of ecological features or receptors, a measure of the significance of effects on marine ecology can be derived.

Significance Criteria

14.3.21 For each marine ecological receptor only those characteristics relevant to understanding the ecological effect and determining the significance are described. The determination of the significance of effects has been made based on the predicted effect to:

- designated sites – i.e. the conservation objectives for the site and / or its interest / qualifying features;
- ecosystems / biodiversity – resulting in a change in ecosystem structure and / or function;
- habitats – i.e. extent, distribution, structure, function as well as its and associated species, and its conservation status within a given geographical area; and
- species – i.e. abundance, distribution (including spawning, foraging and nursery habitats) and its conservation status within a given geographical area or at a particularly sensitive time (e.g. spawning season).

14.3.22 Conclusions on the significance of effects will be assessed as being either:

- Not Significant – no effect to one or more of the features described above; or
- Significant – one or more features described above are affected.

14.3.23 As CIEEM does not advocate a matrix approach for determining significance of effects on ecological receptors (CIEEM, 2018) maintaining consistency with other disciplines, where a matrix approach is suitable, should be considered. Thus, the assessment conclusions presented within this chapter have been translated into the significance terminology used within the wider ES as outlined in Chapter 2: Assessment Methodology (ES Volume I Document Ref. 6.2). See Table 14-3 below.

Table 14-3: Description of Significance Terminology

Classification of effect based on CIEEM guidance	Terminology used elsewhere in the ES	Description in accordance with CIEEM guidance
Significant (beneficial)	Major beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at the international level
	Moderate beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at the national level
Non-significant	Minor beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at a local level or regional level
	Negligible	No effect on designated sites, ecosystems, habitat and species
	Minor adverse	Adverse effect on designated sites, ecosystems, habitat and species at the local level or regional level
Significant (adverse)	Moderate adverse	Adverse effect on designated sites, ecosystems, habitat and species at the national level
	Major adverse	Adverse effect on designated sites, ecosystems, habitat and species at the international level

Study Area

14.3.24 The Study Area used for the assessment has been defined as including the likely ZoI where potential significant effects may arise from the Proposed Development. The Rochdale Envelope has also been applied to ensure that the baseline characterisation data is sufficient to underpin a reasonable worst-case assessment of impact pathways.

14.3.25 The ZoI, and therefore also the Study Area, is specific to each receptor, recognising both the mobility of each receptor and the likely impact pathways to that receptor. A summary of the Study Area for each receptor is defined below. However, more detailed information can be found within the technical appendices that accompany this chapter ES Volume III, Document Ref. 6.4).

- **Designated sites**: the Study Area for the search for relevant nature conservation sites for marine ecology included a 10 km radius of the Site within the marine environment. This spatial extent was chosen on the basis that it provides geographical context and encompasses the relevant functional habitats and range of movement of most species found within the predicted ZoIs of the Proposed Development. However, for European sites designated for marine mammal species the Study Area was extended to include the Greater North Sea Ecoregion (discussed further below under Marine mammals)[5], to account for the wide ranging nature of these animals. For the assessment of impacts from emissions to air on statutory designated sites, this Study Area was extended to a 15 km radius, as per comments within the SoS Scoping Opinion (see Table 14-4).
- **Plankton**: the Study Area for plankton focussed on the Tees Estuary but included the wider coastal area up to and encompassing the Greater North Sea Ecoregion.
- **Benthic ecology:** the intertidal Study Area extends from the south bank of the Tees Estuary to Redcar, encompassing South Gare Breakwater and Coatham Sands (see Appendix 14A, Figure 14A-1, ES Volume III, Document Ref. 6.4). The subtidal Study Area is from Long Scar (7 km to the north) to Redcar Sands (7 km to the south) and up to 7.5 km offshore to the northeast (see Appendix 14D, Figure 14D-1, ES Volume III, Document Ref. 6.4).
- **Fish and shellfish** (including commercial fisheries): the Study Area for this receptor is defined as the area comprising the River Tees, the Tees Estuary, and the wider coastal area up to and including the Greater North Sea out to a distance of 10 km offshore from the Site which encompasses the predicted ZoI for project activities (see Appendix 14B, Figure 14B-1, ES Volume III Document Ref. 6.4).
- **Marine mammals**: the Study Area for marine mammals includes the Greater North Sea Ecoregion (North Sea, English Channel, Skagerrak and Kattegat), recognising the highly mobile and transient nature of this receptor. However, it is understood that the area defined by the

[5] According to the International Council for the Exploration of the Sea (ICES), the Greater North Sea Ecoregion includes the North Sea, English Channel, Skagerrak, and Kattegat. It is a temperate coastal shelf sea with a deep channel in the northwest, a permanently thermally mixed water column in the south and east, and seasonal stratification in the north.

International Council Exploration of the Sea (ICES) as IVb is a particularly important region (see Appendix 14C, Figure 14C-1, ES Volume III, Document Ref. 6.4).

Sources of Information

14.3.26 The baseline conditions for marine ecology were determined using findings from a combination of both desk-based study and field surveys. The Study Area was used to outline the area of search and the location of the field surveys.

14.3.27 The desk-based study identified several publicly available data sources relevant to the Study Area for each marine receptor. The desk-based study determined the nature conservation designated sites and protected species and habitats considered within this assessment on impact pathways from the Proposed Development. Furthermore, the data sources were used to provide the relative importance, functionality, and geographical context of each receptor. The data sources used for the baseline conditions of each ecological feature identified are listed in the technical appendices that accompany this chapter (ES Volume III, Document Ref. 6.4).

14.3.28 To inform the baseline characterisation study and to supplement the ground-truthing of existing information identified in the desk-based study (such as data collected for the Teesside Offshore Wind Farm (OWF) (Entec UK Limited, 2011a)), benthic ecological field studies have been undertaken. Phase I and Phase II intertidal benthic surveys, encompassing the south bank of the Tees Estuary to Redcar, South Gare Breakwater and Coatham Sands, were completed in October 2019. In addition, subtidal benthic ecological surveys, consisting of sediment grab sampling, also undertaken. The subtidal benthic survey took place in December 2019 were and ran from Long Scar to Redcar sands, sampling predominantly in the vicinity of the Water Discharge Connection Corridor of the Proposed Development. These field surveys classified the habitat within each Study Area and highlighted key intertidal and subtidal benthic receptors.

14.3.29 Following consultation with the MMO in December 2020, where details were outlined for the proposed replacement of the outfall infrastructure (within the Water Discharge Connection Corridor), it was agreed that additional intertidal Phase II sampling would be undertaken. As such, six additional core samples were taken at low tide on the 5th February 2021 by experienced marine ecologists, at the stations shown in Figure 14A-1, ES Volume III, Document Ref 6.4.

14.3.30 The full scope, methodology and results of these surveys can be found within the relevant technical appendices (Appendix 14A: Intertidal Benthic Ecology Survey Report and Appendix 14D: Subtidal Benthic Ecology, (ES Volume III, Document Ref. 6.4). A figure detailing the full coverage of surveys is shown on Figure 14-1: Benthic Survey Study Area and Sampling (ES Volume II, Document Ref. 6.3).

Consultation

14.3.31 Consultation for the Proposed Development has been ongoing and commenced at the EIA Scoping Stage with the preparation of the EIA Scoping Opinion Report which was submitted in February 2019. The Scoping Opinion was then received from the Planning Inspectorate in April 2019. These are presented in Appendix 1A and 1B (ES Volume III, Document Ref. 6.4).

14.3.32 Following the Stage I consultation in Autumn 2019, the Applicant undertook a formal Section 42 and Section 47 consultation between 30 June and 18 September 2020. A Preliminary Environmental Information (PEI) Report formed part of the basis of the Stage II consultation. The issues that have been raised through consultation, and how these have been considered and addressed within the design evolution of the Proposed Development and the EIA is set out, where relevant, within each of the topic chapters in the ES and, where relevant, in Chapter 6: Alternatives and Design Evolution (ES Volume I, Document Ref. 6.2).

14.3.33 Table 14-4 provides a summary of how comments raised by stakeholders to date in relation to marine ecology have been considered and actioned where appropriate.

Table 14-4 Summary of Consultation Responses

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
Secretary of State (SoS) Scoping Opinion, 4.6.3, Study area: The Inspectorate considers that a study area of 15 km should be applied to assess impacts from emissions to air on statutory designated ecological sites as per EA / Defra guidance.	A Study Area of 15 km has been used for the assessment of impacts from emissions to air on statutory designated sites. All impact pathways to marine ecological receptors have been identified in this chapter along with justification of the proposed Study Area.
SoS Scoping Opinion, 4.6.5, Baseline Surveys: It is unclear whether the Extended Phase 1 Habitat Surveys covered the entirety of the application site or just the Main Site.	Extended Phase I surveys have been carried out across the full extent of the Site. In November 2019, a dedicated Phase I and Phase II intertidal benthic survey was undertaken to characterise the ecological baseline within the proposed Site boundary. Further information (including the Study Area) can be found in Appendix 14A: Intertidal Benthic Ecology Survey Report (ES Volume III, Document Ref. 6.4). Based on feedback from the MMO and their advisors at the Centre for Environment, Fisheries and Aquaculture Science (Cefas), additional Phase II intertidal sampling was undertaken in February 2021.
SoS Scoping Opinion, 4.6.6, Marine Ecology: The scope of baseline ecological surveys does not include surveys for benthic species, marine mammals, shellfish, fish or eels. However, impact pathways to aquatic habitats and water quality in the River Tees / North Sea are identified.	Since submission of the Scoping Opinion, work has been ongoing to characterise the marine ecology baseline. This has culminated in the production of four appendices covering intertidal benthic ecology (Appendix 14A: Intertidal Benthic Ecology Survey Report), subtidal benthic ecology (Appendix 14D: Subtidal Benthic Ecology), fisheries and fish ecology (Appendix 14B: Fisheries and Fish Ecology Baseline), and

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
The ES should explain the baseline conditions in respect to marine ecology and effort should be made to agree the sufficiency and location of any baseline surveys with relevant consultation bodies.	marine mammals (Appendix 14C: Marine Mammal Ecology Baseline) (ES Volume III, Document Ref. 6.4). A summary of the findings can be found in Section 14.4: Baseline Conditions of this ES chapter.
The ES should also identify impact pathways to marine ecology and assess any likely significant effects, as well as describe any measures proposed to mitigate such impacts. Finally, the ES should include confirmation of how any such measures are secured.	Baseline surveys have been completed for intertidal and subtidal benthic ecology. Characterisation of baseline conditions for all remaining marine ecological receptors has drawn upon desk-based literature and publicly available data sets. This approach to baseline characterisation was communicated to and agreed with the MMO during a stakeholder meeting held on 26th September 2019; this included the basis for and specific locations of individual sampling locations. Since this point, additional engagement with the MMO has been undertaken in February 2020, August 2020, December 2020 and February 2021 to inform the EIA. All impact pathways to marine ecology which are outlined within Section 14.6: Likely Impacts and Effects of this ES chapter have been assessed. Where it is considered that mitigation is required, these measures have been described and secured within the Construction Environmental Management Plan (CEMP); a Framework CEMP is included in the Application (Appendix 5A, ES Volume III, Document Ref. 6.4).
SoS Scoping Opinion, 4.6.7, Guidance: The ecology assessments within the ES should be undertaken with the most up-to-date version of the CIEEM guidelines.	As outlined above, the EcIA has been completed in accordance with the latest CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2019).
SoS Scoping Opinion, 4.6.11, Habitat gain / loss: The ES should identify and quantify all temporary and permanent habitat gains and losses by type (including any functionally linked land).	Temporary and permanent gains and losses of intertidal and subtidal marine habitats have been quantified where information on the design of the Proposed Development is available. Where necessary, a suitable worst-case scenario has been assessed, as discussed in Section 14.3. This is provided within this ES Chapter (see Section 14.6: Likely Impacts and Effects) according to the lowest (i.e. most detailed) possible EUNIS habitat classification level (EEA, 2012).
SoS Scoping Opinion, 4.6.12, Invasive species: Surveys should be undertaken to identify the presence of any invasive species on the application site and any necessary eradication / control measures detailed in the ES.	The presence of any INNS has been recorded during the characterisation of baseline conditions and is summarised in Section 14.4: Baseline Conditions below with further information provided within the supporting appendices (ES Volume III, Document Ref. 6.4).
EA, Scoping Opinion pg. 72, 25-Year Environment Plan: Developments should be looking to enhancement of the environment and	This comment is acknowledged. Based on the assessment of worst-case it has been identified that no additional biodiversity enhancement

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
not just to mitigate. The level of mitigation / compensation for nationally designated sites should be based on the ecological potential of the sites and not on the current ecological value.	measures to offset loss of marine biodiversity would be required (see paragraph 14.6.23). However, ecological (marine) enhancement measures would be considered, as appropriate, in the event that a replacement outfall / outfall head is required. Examples of practical measures could include the cutting of grooves in rock armouring and insertion of pilot holes to help promote faunal colonisation of material.
EA, Scoping Opinion pg. 72, Designated sites and habitats: Consideration must be made to all designated sites or locally non-statutory sites which fall within the boundary. This includes the Teesmouth National Nature Reserve (NNR).	Teesmouth NNR includes important intertidal mudflat habitats at Seal Sands and tidal lagoon habitat. Thus, this designated site has been considered through this ES chapter (likely impacts and effects are discussed in Section 14.6).
EA, Scoping Opinion pg. 73, Biodiversity and Environmental Opportunities: Opportunities to delivery environmental enhancement and net gain in collaboration with organisations such as the Tees Estuary Partnership and should be sought to mitigate or compensate for impacts to habitats and species.	This comment is acknowledged. No additional biodiversity enhancement measures are currently anticipated in terms of marine ecology, as discussed above. Notwithstanding, an Indicative Landscape and Biodiversity Strategy has been prepared and submitted with the Application (Document Ref. 5.12). This sets out the approach to site appropriate landscape and biodiversity mitigation and enhancement. It also confirms that the proposed enhancement measures are suitable to achieve no net loss and a gain in biodiversity within the PCC Site.
EA, Scoping Opinion pg. 73, Estuarine and Coastal Environment: We recommend that the development proposal incorporates as best available practice Estuary Edges habitat designs on any existing or newly constructed structures that intersect the inter tidal zone. The 'IMMERSE' project funded through EU Interreg is currently piloting implementation of such measures in the Tees Estuary through the Tees Rivers Trust.	This comment is acknowledged. Based on the assessment of worst-case it has been identified that no additional biodiversity enhancement measures to offset loss of marine biodiversity would be required (see paragraph 14.6.23). A range of best-practice measures are set out in the CEMP; a Framework CEMP is included in the Application (Appendix 5A, ES Volume III, Document Ref. 6.4).
EA, Scoping Opinion pg. 74, No net loss of intertidal habitat: The EA is committed to no net loss of intertidal and subtidal habitat. When encroachment is shown in plans for any new works, considerable justification for this, together with details of mitigation and compensation would need to be included.	This comment is acknowledged. Details of mitigation measures relevant to the assessment of effect to intertidal and subtidal habitats are provided in Sections 14.5: Development Design and Impact Avoidance and 14.7: Mitigation and Enhancement Measures of this ES chapter.
EA, Scoping Opinion pg. 74, Fish and eels: The DCO application must take protected fish species and eels into consideration, as the development will have impacts on the River Tees, which contains protected fish species, including Salmon, Sea trout, Eel and Lamprey. Eels are specifically covered within the Eel (England and Wales) Regulations 2009.	All impact pathways to migratory fish species including salmon, sea trout, eel and lamprey have been considered within the ES. During the course of the design development and EIA process, the flexibility for using the River Tees Abstraction has been refined out; this substantially reduces (in several cases removes) a suite of potential effects on diadromous species using the River Tees. The characterisation of fisheries, approach to assessment and key mitigation has been

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
Activities that are likely to affect fish migration need to be fully considered for their impact pathways, and necessary mitigation measures agreed with the EA to prevent damage to any protected species.	discussed and agreed with the EA throughout the pre-application process. An overview of the likely impacts and effects to migratory fish species can be found in Section 14.6: Likely Impacts and Effects of this ES chapter with information about relevant mitigation provided in Sections 14.5: Development Design and Impact Avoidance and 14.7: Mitigation and Enhancements Measures.
EA, Scoping Opinion pg. 74, Entrainment: All endeavours should be taken to avoid entrainment. The abstraction should comply with screening guidance in relation to the eel regulations.	The cooling technology for the Proposed Development will be a hybrid system, representing a combination of both wet and dry cooling. Raw water will be provided by Northumbrian Water Ltd via the existing watering meter house along the Water Connection Corridor. Thus, there is no longer a requirement to abstract water from the River Tees. This method results in no risk of entrainment and as such, there will be no upgrade to the existing intake screens as they will no longer be utilised.
EA, Scoping Opinion pg. 75, Piling restrictions: Temporal restrictions may be imposed on any works taking place in the Tees Estuary or coastal waterbodies that could impact the passage of migratory fish.	Potential temporal restrictions to piling are acknowledged, although piling will no longer take place in the River Tees; this substantially reduces (in several cases removes) a suite of potential effects on diadromous species using the River Tees. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; no requirement for a seasonal restriction on works has been requested or identified. A DML is provided with the Application in the draft DCO (Document Ref. 2.1).
EA, Scoping Opinion pg. 75, Dredging: Any dredging works carried out between March and November, in any given year will require a silt mitigation plan and / or appropriate water quality monitoring programme must be implemented in accordance with a scheme agreed with the EA.	Should dredging works be required as part of the Proposed Development, they will be subject to a range of licensing conditions as secured within the DML; the draft DML has been subject to MMO discussion and formal review and is provided with the Application in the draft DCO (Document Ref. 2.1). This includes sediment sampling and a methodology return; it is anticipated that if necessary, any silt mitigation would be specified within this methodology. The potential effects arising from dredging are considered within this ES chapter (likely impacts and effects are discussed in Section 14.6).
EA, Scoping Opinion pg. 75, INNS: INNS must be included in future ecological assessments and considered within the DCO application, so an informed decision can be made regarding any mitigation for potential adverse effects.	Marine INNS have been considered as part of the baseline characterisation detailed within this ES chapter and supporting appendices (ES Volume III, Document Ref. 6.4). Impact pathways of the Proposed Development on the introduction and spread of INNS have been considered within Section 14.6: Likely Impacts and Effects of this ES chapter.

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
Marine Management Organisation (MMO), Scoping Opinion pg. 100, Planning policy: It should be noted that, while the Project includes the potential for works below MHWS [Mean High Water Springs], consideration must be given to any relevant marine plans.	The Site falls within the North East Inshore Plan area. At the time of writing the plan is yet to be adopted and therefore the ES demonstrates compliance with the MPS, being the relevant policy document at the time of its publication. Based on the current content of the draft North East Marine Plan, the ES is considered to be compliant with the broad scope of these plan policies. Regard has been given to the MPS within this ES chapter (see paragraphs 14.2.13 and 14.2.14).
MMO, Scoping Opinion pg. 100, Potential significant environmental issues: While a wide range of impact pathways to marine ecology have been scoped in, very little information has been provided with regards to the baseline features or specific impact pathways. The MMO would expect this to be presented in detail during the EIA process.	Since submission of the Scoping Report, work has been ongoing to characterise the marine ecological baseline. This information can be found in Section 14.4: Baseline Conditions of this ES chapter and the supporting appendices (ES Volume III, Document Ref. 6.4). All impact pathways on marine ecology which are outlined within Section 14.6: Likely Impacts and Effects are assessed in this ES Chapter. Detailed discussions with the MMO and their technical advisors (Cefas) have been undertaken through the pre-application period to inform the EIA.
MMO, Scoping Opinion pg. 100, Potential significant environmental issues: Should works be required within intertidal or estuarine areas of the River Tees and / or North Sea, then the EIA should provide a characterisation of fish ecology by identifying the fish species and habitats within the Study Area which may be subject to the impacts of activities.	A detailed characterisation of fish ecology relevant to the Proposed Development can be found in Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4), with a summary of this information presented in Section 14.4: Baseline Conditions of this ES chapter.
MMO, Scoping Opinion pg. 101, Potential significant environmental issues: The report appears to lack any reference to or consideration of impact pathways on local fisheries – and marine ecology – arising from the use of seawater as a means to cool the CCGT.	The comment is acknowledged. Consideration of potential impacts to marine ecology forms the focus of this ES chapter and supporting appendices (ES Volume III, Document Ref. 6.4). The assessment of potential effects on fisheries is supported by Appendix 14B: Fisheries and Fish Ecology Baseline Report (ES Volume III, Document Ref 6.4) specifically. The local MMO (fisheries / enforcement) team and the NEIFCA were both consulted on this report. Notwithstanding, the removal of the option to abstract water from the River Tees reduces the key potential impact associated with entrainment of fisheries. In terms of wider disturbance to commercial fishing activity, consideration of impact pathways on local fisheries can be found in Chapter 20: Socio-economics and Tourism (ES Volume I, Document Ref. 6.2) as well as Appendix 20B: Navigational Risk Assessment (ES Volume III, Document Ref. 6.4).
MMO, Scoping Opinion pg. 101, Potential significant environmental issues: At this stage Project details are limited, for example it is	Detailed information related to application of the Rochdale Envelope and the reasonable worst-case scenarios assessed can be found in

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
currently unknown if existing infrastructure and / or tunnels can be used or if new infrastructure and / or tunnels will be required. As such, it is impossible to understand impact pathways on fisheries and / or other marine users. The MMO would expect that, moving forward, impact pathways on local fisheries and other marine users are considered during the EIA process.	Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2) and Chapter 5: Construction Programme and Management (ES Volume I, Document Ref. 6.2).A summary is presented in Section 14.3: Assessment Methodology and Significance Criteria of this ES chapter. This forms the basis of the assessments presented in Section 14.6: Likely Impacts and Effects of this ES chapter including impact pathways for commercial fisheries. Further information on impacts to local fisheries and other marine users can be found in Chapter 20: Socio-economics and Tourism (ES Volume I, Document Ref. 6.2) and Appendix 20B: Navigational Risk Assessment (ES Volume III, Document Ref. 6.4).
MMO, Stage II Response pg. 5), Impact Assessment The MMO would expect to see further detail in the subsequent ES on the impacts to the marine environment and its associated receptors	More information has been provided on the Proposed Development in Chapter 4: Proposed Development and Chapter 5: Construction Programme and Management of the ES Volume I, Document Ref. 6.2. The impact assessment for the marine environment has provided more detail where possible. As has been discussed with the MMO, where finite information is not available on a specific element of the Proposed Development, worst-case assumptions have been adopted.
MMO, Stage II Response pg. 6, Fisheries The MMO expect more consideration on the protection of migratory fish species from underwater noise in the River Tees. They propose that addition measures should be included, such as temporal restrictions on piling to avoid key migratory periods for fish[…].	Piling will no longer take place in the River Tees; this substantially reduces (in several cases removes) a suite of potential effects on diadromous species using the River Tees. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; no requirement for a seasonal restriction on works has been requested or identified. A DML is provided with the Application in the draft DCO (Document Ref. 2.1). Good practice and design mitigation measures have been proposed in this ES chapter (see Section 14.5: Development Design and Impact Avoidance). These measures are in accordance with industry best-practice and Joint Nature Conservation Commission (JNCC) guidance. This may include the soft-start of pin pilling (to be undertaken in Tees Bay, to secure the new outfall head).
MMO, Stage II Response pg. 6, Rock Armouring The MMO question whether the rock armouring will be located on current sedimentary habitat or a hard substratum habitat.	This is outlined in paragraph 14.6.16, which states that the rock armouring would have an effect on subtidal sandflats.
MMO, Stage II Response pg. 6, Fisheries The MMO expect to see more consideration of the different speeds and capabilities of fish depending on their species or development stages.	This ES chapter has provided more detail on the potential effects on different life stages and species of fish. For example, paragraph 14.6.29 discusses the potential effects on juvenile life stages such as glass eels, taking into

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
	consideration their swimming ability. However, it is understood from discussions with the MMO that a key driver for this comment was underwater noise from piling within the Tees Estuary. Piling will no longer take place in the River Tees; this substantially reduces (in several cases removes) a suite of potential effects on diadromous species using the River Tees.
MMO, Stage II Response pg. 6, Fisheries The MMO recommend the inclusion of information from the Fish Atlas of the Celtic Sea, North Sea and Baltic Sea (Heessen et al., 2015) to supplement baseline information.	We thank the MMO for this valuable feedback. Information from this reference has been added to Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4) and included within this ES Chapter where appropriate. The local MMO (fisheries / enforcement) team and the NEIFCA were both consulted to help inform this report.
MMO, Stage II Response pg. 7, Shellfisheries The MMO expect to see further information in relation to commercial shell fishing in the area, with consultation with local shellfish works and the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA) […] This should be supplemented with vessel monitoring system (VMS) data and data sources which provide information on the activity of vessels under 10 m.	More information has been provided on commercial fisheries, including details of shell fishing, in Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4). The local MMO (fisheries / enforcement) team and the NEIFCA were both consulted to help inform this report. Regarding the NEIFCA specifically, consultation was undertaken with the NEIFCA in February 2021; this confirmed that all available sources had been used to inform the commercial fisheries baseline study. The baseline conditions for commercial fisheries within the study area have been provided in Section 14.4: Baseline Conditions, whilst additional impact pathways on this receptor have been assessed in Section 14.6: Likely Impacts and Effects. Some of the limitations associated with 'conventional' sources of data, such as landings, have been openly acknowledged, including during Stage II public consultation and subsequent discussions with the MMO and Cefas. The MMO local office / fisheries team were consulted on the scope of fisheries datasets in February 2020. Further consultation was attempted on multiple occasions between February 2020 and January 2021. No responses have been received and the range of data provided, together with IFCA / MMO licensing team consultations, is considered robust for the ES.
MMO, Stage II Response pg. 7, Cumulative Impacts The MMO would expect to see information on any cumulative impacts which may arise from this project.	Cumulative impacts have been considered further and are presented in Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2). As discussed in Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2), the offshore works below MLWS are being progressed under separate consent,

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
	however potential combined effects of the onshore and offshore works are given specific consideration in Appendix 24C: Statement of Combined Effects (ES Volume III, Document Ref. 6.4).
MMO, Stage II Response pg. 7, Underwater Noise The MMO consider the wave mode coefficient for cylindrical spreading (i.e. A=10) to be very conservative and would suggest using 15 log R (assuming B is 0).	With the exception of UXO, where a wave coefficient of A = 10 has been used, geometric spreading calculations for all construction and geophysical activities have adopted a wave coefficient of A=15.
MMO, Stage II Response pg. 8, Underwater Noise The MMO state that in Table 14-11, 150 dB SPLrms has been provided, but the correct Temporary Threshold Shift threshold figure should be 158 dB SPLrms.	This was a typing mistake in the table and has now been corrected. The distances calculated are correct.
MMO, Stage II Response pg. 8, Underwater Noise The MMO highlight errors in Table 14-14 and Table 14-16, stating that NMFS (2018) intends for the weighted SEL_{cum} metric to account for the accumulated exposure, i.e. over the duration of the activity within a 24-hour period. This means that if the noise generating activities occur over a shorter period within the 24-hour window, then, a receptor is at risk within the predicted auditory effect zone during the duration of activity. For the activities that may last more than 24 hours, the accumulation period accounts only for 24 hours of continuous activity. Thus, information on the anticipated duration of the various activities in a 24-hour period will be required.	The sound propagation calculations have been updated to include data for a 24-hour exposure time to indicate a range of potential impact zones as sound generating activities will take place over different time periods, as detailed in the assessment.
MMO, Stage II Response pg. 8, Fisheries The MMO would like to see how the project will be in line with the priorities of the River Tees Salmon Action Plan. Furthermore, it is recommended that the applicant liaise with IFCA, to ensure all impacts on fish and fisheries have been considered.	The priorities of the River Tees Salmon Action Plan have been discussed in paragraph 14.4.41, signposting to relevant sections within this ES Chapter. Consultation has been undertaken with the NEIFCA; this has confirmed the approach to and findings of the impact assessment. As noted above, consultation with the MMO fisheries / enforcement team was attempted in order to inform the assessment although no response was received.
MMO, Stage II Response pg. 8, Underwater Noise The MMO expect to see consideration for peer-reviewed literature on the negative effects of underwater sound on marine invertebrates.	The potential effects of underwater sound on marine invertebrates has been discussed in more detail in paragraph 14.6.65 onwards, prepared with reference to the most current literature available at the time (researched in early 2021). This has also been subject to specific discussion with the MMO in February 2021.

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
Environment Agency, Stage II Response pg. 8, Sedimentology Consideration should be given to the impact of sediment contamination affecting the water quality and chemical status of the waterbody it's carried out in. This may require further testing and leachate samples from marine sediments listed over CEFAS level 1.	Consideration of the disturbance of contaminant within the marine environment has been considered and is documented within this ES Chapter (see paragraphs 14.6.32 and 14.6.53). The vast majority of sampling data within the area indicates that material is below Cefas Action Level 1 with some material between Action Level 1 and 2. However, preparatory dredging within the River Tees is no longer required; this vastly reduces the risk of disturbance of sediment with a higher contamination level. Outside of the River Tees, the extent of anthropogenic activity is greatly reduced. Historical sampling undertaken within the Tees Bay indicates that the material is highly unlikely to be a contaminant risk (see Appendix 14D Subtidal Benthic Ecology, ES Volume III, Document Ref. 6.4). This is discussed further in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2). In order to further safeguard the marine environment and ensure maintenance – or improvement of – water quality, draft conditions are included in the DML in the draft DCO (Document Ref. 2.1) to require the completion of material sampling before dredging works can commence. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; a DML is provided with the Application in the draft DCO (Document Ref. 2.1).
Environment Agency, Stage II Response pg. 12, Biosecurity Strict biosecurity measures should be implemented to avoid the importing of non-native invasive species. Equipment, plant and Personal Protective Equipment (PPE) brought to site should be clean and free of material and vegetation.	Noted and this feedback is welcome. The management of INNS is an important topic and one which is considered within Section 14.6: Likely Impacts and Effects. Details of biosecurity measures are provided within the CEMP and a Framework CEMP is included in Appendix 5A of the ES (ES Volume III, Document Ref. 6.4). In addition, it is anticipated that the MMO will require details of biosecurity measures to be provided during the discharge of DML conditions related to the discharge of construction methodologies.
Environment Agency, Stage II Response pg. 11, Underwater Noise The report states that they will consider impacts of noise on fish. We would expect to see mitigation for activities such as piling adjacent to the watercourse. Reduction of noise from boat traffic during construction is noted.	Impacts on fish populations from noise are assessed within Section 14.6: Likely Impacts and Effects. This is supported by a highly precautionary modelling exercise to consider the extent of any underwater noise impacts arising from the construction of the Proposed Development. The nature of piling close to or within the watercourse is highly limited. Only a short

Key issue raised (by whom, ID / page no., theme)	Response to issue raised and action taken where appropriate
	campaign of pin piling may be required to secure the new outfall head in the Tees Bay. Piling will no longer take place in the River Tees; this substantially reduces (in several cases removes) a suite of potential effects on diadromous species using the River Tees. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; no requirement for a seasonal restriction on works has been requested or identified. A DML is provided with the Application in the draft DCO (Document Ref. 2.1).
Environment Agency, Stage II Response pg. 13, Fisheries Fish entrainment in cooling water intakes is described as an impact. This would require suitable mitigation and prevention measures would need to be demonstrated. Thermal impacts from the discharged water would be expected to be modelled and adequate measures taken to prevent any impact on fish communities.	Raw water will be provided by Northumbrian Water Ltd via the existing watering meter house along the Water Connection Corridor. Thus, there is no requirement to abstract water from the River Tees and there will be no risk of entrainment of fish.
Environment Agency, Stage II Response pg. 13, Habitat Loss Section 14.6.11 details permanent habitat loss within the subtidal zone which may occur underneath the outfall head and any associated rock armouring / scour protection. We would like to see ecological enhancement techniques considered within the rock armour to increase biodiversity of the artificial structure.	This comment is acknowledged. No additional biodiversity enhancement measures are currently anticipated to be required in terms of marine ecology, as discussed above. Industry best-practice and ecological (marine) enhancement measures would be considered, as appropriate, in the event that a replacement outfall (to the south east of the existing outfall positioned next to the CO_2 Export Pipeline) is required. Examples of practical measures could include the cutting of grooves in rock armouring and insertion of pilot holes to help promote colonisation of material. Alongside this, an Indicative Landscape and Biodiversity Strategy has been prepared and submitted with the Application (Document Ref. 5.12). This sets out the approach to site appropriate landscape and biodiversity mitigation and enhancement. It also confirms that the proposed enhancement measures are suitable to achieve no net loss and a gain in biodiversity within the PCC Site.
Environment Agency, Stage II Response pg. 16, Thermal Modelling [A series of comments were made by the Environment Agency on the Coastal – Thermal – Modelling Report].	We welcome the feedback from the Environment Agency on the Coastal Modelling Report. Based on feedback provided during Stage II consultation and in technical engagement meetings in March 2019, January 2021 and February 2021, the Coastal Modelling Report has been refined; an updated report is presented in Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4). This report also considers far-field effects from the discharge of treated effluent using the Delft3D model.

14.3.34 On 26th September 2019, a meeting was held with the MMO in order to demonstrate the progress which had been made with respect to marine matters since the Scoping Opinion was received in April 2019. During this meeting, the MMO was presented with further information about the Proposed Development and the marine scope including the ecological baseline, stakeholder engagement and consenting. Details on how marine matters would be considered within the developing PEI (to input into this ES Chapter) were also discussed.

14.3.35 A further engagement meeting was held with the MMO on the 13th February 2020 where additional progress on the Proposed Development and scope of marine assessment was presented. During this meeting, the MMO was also presented with information on how key marine topics were being addressed; this included aspects of thermal modelling, sedimentology and potential dredging and disposal activities.

14.3.36 On the 13th July 2020 the MMO were notified of the intention to submit an application for development consent for the Proposed Development under the Planning Act 2008 (the 2008 Act). Consultation documents, including the PEI report, were also provided to the MMO on this date, for consultation with their scientific advisors at Cefas. Table 14-4 provides an account of the comments raised by the MMO in relation to marine ecology and how these have been considered and actioned where appropriate.

14.3.37 Further meetings were held with the MMO (26th August 2020, 26th September 2020 and 12th December 2020) to discuss and clarify the comments made as part of PEI consultation (outlined in Table 14-4) and to provide further details on the Project Design and intentions for the ES.

14.3.38 In the meeting held on the 12th December 2020, details were outlined to the MMO for the proposed replacement of the outfall infrastructure to run along the CO_2 Export Pipeline, within the Water Discharge Corridor. The existing sampling and baseline information for the subtidal benthic ecology in the Tees Bay, including the macrofaunal assemblages, substrata and exposure conditions, were presented to the MMO. Following this meeting, the MMO consulted with their scientific advisors at Cefas, and concluded that additional sampling was required in the shallow subtidal zone in proximity to the proposed replacement outfall within the Water Discharge Connection Corridor. It was agreed that a further six samples should be taken at low tide to supplement existing data and to underpin a comprehensive characterisation of benthic habitats in Tees Bay. As such, additional intertidal phase II sampling was undertaken on the 5th February 2021, the results for which are presented in Appendix 14A: Intertidal Benthic Ecology Survey Report (ES Volume III, Document Ref. 6.4).

14.3.39 In addition to technical engagement with the MMO, engagement has also been undertaken with the Environment Agency; this includes engagement meetings on the 26th March 2020 and on the 18th January 2021. A number of specific topics have been discussed with the Environment Agency which have relevance to Marine Ecology; this includes thermal modelling, assessment of water quality effects arising from discharges, and hydrology.

14.3.40 The specific requirements for chemical modelling of the treated effluent was also discussed with the Environment Agency. As discussed with the

Environment Agency, the exact nature and composition of the treated effluent has not been fully characterised at this early stage in the design process. On the basis that the effluent will need to demonstrate compliance with the relevant Equivalent Quality Standard (EQS) for each component of the effluent and as the effluent will be subject to the regulatory control and monitoring procedures under the Environmental Permitting regime, no modelling has been proposed or completed. The need for any site/effluent-specific controls will be determined through the Environmental Permit application process.

14.4 Baseline Conditions

14.4.1 The marine ecological baseline relevant to the Proposed Development is summarised below. Further findings of the desk and field-based studies, including evaluation of the relative conservation value of identified ecological features is provided within the technical appendices that accompany this chapter (ES Volume III, Document Ref. 6.4).

Designated Sites

14.4.2 The Proposed Development is situated within the Teesmouth and Cleveland Coast Special Protected Area SPA / Ramsar site and the Teesmouth and Cleveland Coast SSSI. These sites are designated for the protection of breeding / non-breeding bird species and other important waterfowl species associated with the site and include a range of coastal habitats (sandflats and mudflats, rocky shore, saltmarsh, freshwater marsh and sand dunes) within and around the Tees Estuary.

14.4.3 As of January 2020, the proposed extension to the existing Teesmouth and Cleveland Coast SPA and Ramsar site has been formally adopted and is intended to protect important marine foraging areas for breeding terns as well as intertidal areas and estuarine waters used by wintering birds. Intertidal areas are known to support benthic invertebrate communities which provide an important food resource for the majority of bird species found to occur in the area (Natural England, 2018).

14.4.4 The Teesmouth and Cleveland Coast SSSI encompasses a number of previously designated SSSI sites, including the Seal Sands SSSI, located 2.9 km to the west of the Site, which supports a breeding population of harbour seal (*Phoca vitulina*). The area is also used as a haul-out site by grey seal (*Halichoerus grypus*) (INCA, 2019).

14.4.5 Whilst direct and indirect effects to coastal seabirds and associated designated sites (e.g. the Teesmouth and Cleveland Coast SPA / Ramsar) will be covered in Chapter 15: Ornithology (ES Volume I, Document Ref. 6.2), consideration has been given to the Teesmouth and Cleveland Coast SSSI within this chapter owing to the importance of supporting coastal and marine habitats for seals.

14.4.6 The Site does not overlap with any other European Sites or MCZs designated for marine species and habitats.

14.4.7 The nearest SACs designated for marine mammal species are located between 86 km and 211 km from the Site. The only SAC for which there is considered to be a pathway for impact is the Southern North Sea SAC which

is designated for harbour porpoise – further information can be found in paragraph 14.4.63 below.

14.4.8 Runswick Bay is the nearest MCZ, located over 20 km to the south-east of the Site. This site is designated for a range of intertidal and subtidal habitats as well as the ocean quahog (*Arctica islandica*), a species of edible clam (Defra, 2016). There is considered to be no pathway for impact to this site and it has therefore been scoped out from requiring assessment within Section 14.6: Likely Impacts and Effects.

Plankton

14.4.9 Plankton includes a diverse array of small organisms including plants (known as “phytoplankton”) and animals (known as “zooplankton”) which live predominantly in the upper portion of the water column and are generally unable to swim independently of water currents. Also included are bacteria, algae and the early life stages of a range of species. Plankton provide a crucial food source to other animals and whilst generally microscopic in size, they include a wide range of organisms including jellyfish.

14.4.10 Since 2003, the EA has been sampling phytoplankton on a monthly basis at six sites within the lower portion of the Tees (downstream of the Tees Barrage). The most coastal site (‘The Gares’) is located at the mouth of the Estuary (Environment Agency, 2019a).

14.4.11 The most recent six-years of data (2012 – 2017 and 2019) have shown that peak phytoplankton abundance typically occurs between April and July, peaking in June (at approximately 4.5 million cells L^{-1}). The lowest abundances were observed during the winter months (December to January: <941,805 cells L^{-1}). Inter-annual variability in phytoplankton abundance since 2012 has ranged from an average of 101,778 cells L^{-1} (2012) to 2.6 million cells L^{-1} (2013 and 2019).

14.4.12 The composition of the phytoplankton community recorded in the Tees represents that found typically in UK estuaries. The most abundant taxa were diatoms, followed by cyanophytes, euglenophytes and microflagellates. Combined, these taxonomic groups represented 99% of the annual average abundance of phytoplankton.

14.4.13 No protected phytoplankton species or INNS were identified during the EA surveys, but five taxa known to cause harmful algal blooms in UK coastal waters were recorded. These included: *Alexandrium* spp., *Karenia mikimotoi*, *Dinophysis acuminata*, *Dinophysis acuta*, and *Pseudo-nitzschia* spp. which are all known to cause shellfish poisoning (Defra, 2008). In addition, several taxa known to cause mortality in fish due to physical damage were also recorded; these included *Gymnodinium* spp., *Dictyocha speculum*, *Chaetoceros spp. and K. mikimotoi* (Defra, 2008; ICES, 2018).

14.4.14 The EA survey data for the Tees Estuary suggests that *Alexandrium* spp., *K. mikimotoi* and *Dinophysis* spp. are the only phytoplankton taxa which are known to occur in potentially harmful abundances. No formal monitoring of harmful algal blooms is carried out within the lower Tees Estuary or coastal water bodies (Environment Agency, 2019b). The Tees WFD water body, which covers the lower reaches of the estuary, is classified as having ‘Good’

phytoplankton status despite Seal Sands being recognised as a sensitive eutrophic area (Environment Agency, 2019b; 2019c).

14.4.15 Zooplankton communities in the North Sea are dominated in terms of biomass and productivity by copepods, particularly *Calanus spp. including C. finmarchicus* and *C. helgolandicus* (DECC, 2009). Other important taxa include *Acartia* spp., *Temora longicornis* and *Oithona* spp. The larger zooplankton, known as megaplankton, includes euphausiids (krill), thaliacea (salps and doliolids), siphonophores and medusae (jellyfish). Decapod larvae are also an important component of the zooplankton assemblage. Zooplankton species richness is generally higher in the northern North Sea than in the southern North Sea, with northern communities also displaying greater seasonal variability (Lindley and Batten 2002).

14.4.16 Observed changes in the biogeographic distribution of many zooplankton species (e.g. the northward expansion of warm water species and a northward retreat of cold-water species) are likely to be due to variations in the hydro-climatic conditions (i.e. increased sea temperatures). The extent of the northward shift in plankton distribution over the past 40 years has equated to about 10° in latitude and appears to have accelerated since 2000 (EEA, 2012). Several INNS (including the cladoceran *Penilia avirostris* and the copepod, *Pseudodiaptomus marinus*) are known to have been introduced to the North Sea due to human activities and have responded to favourable conditions (Johns, unpublished cited in DECC, 2009; Edwards *et al*., 2014).

Benthic Ecology

14.4.17 In October 2019, a combined Phase I and II intertidal benthic survey was undertaken in order to characterise the intertidal habitats and species present within the vicinity of the Site. The scope, coverage and approach to this survey programme was discussed with the MMO via a technical engagement meeting on the 26th September 2019.

14.4.18 Three replicate core and grab samples were taken from each of 10 intertidal sampling sites (see Appendix 14A, Figure 14A-1, ES Volume III, Document Ref. 6.4). An additional six core samples were taken in February 2021 in the intertidal zone of Coatham Sands during low tide, following consultation with the MMO and Cefas. This extra sampling was done with the aim to better characterise the benthic ecology in proximity to the proposed CO_2 Export Pipeline, to the South East of the existing samples.

14.4.19 A grab survey was completed in December 2019 to characterise subtidal habitats and communities with three replicate grab samples taken from 23 subtidal stations (see Appendix 14D, Figure 14D-1, ES Volume III, Document Ref. 6.4).

14.4.20 Taxonomic analysis was undertaken by a NMBAQC (North Atlantic Marine Biological Analytical Quality Control) participating laboratory. All surveys and sample analysis were carried out in accordance with relevant best practice guidance (Davies *et al*., 2001).

14.4.21 Sediment samples collected from the 10 intertidal stations and 10 of the 23 subtidal stations were also analysed for abiotic indicators including organic matter, Particle Size Distribution (PSD), heavy and trace metals, and other contaminants (organotins, hydrocarbons and polychlorinated biphenyls and

organochlorine pesticides). Laboratory analysis was informed by the MMO's requirements for Marine Licensing (MMO, 2018a) and carried out at an accredited laboratory.

14.4.22 The Study Area and sampling locations for the benthic surveys are shown in Figure 14-1: (ES Volume II, Document Ref. 6.3). The extent of the Study Area was determined based on project design information available at the time, relevant guidance[6], and an understanding of the extent of likely impacts of the Proposed Development. The indicative sampling locations were also discussed and agreed during pre-application engagement with the MMO, and refined during subsequent discussions with the MMO and Cefas.

14.4.23 The following subsections provide an overview of the project-specific survey data as well as the published information which has been used to characterise baseline conditions for benthic ecology within the Study Area. Further information can be found in Appendix 14A: Intertidal Benthic Ecology Survey Report and 14D: Subtidal Benthic Ecology (ES Volume III, Document Ref. 6.4).

Intertidal Benthic Ecology

14.4.24 Results of the Phase I and macrofaunal sampling showed that the Study Area could be divided into four geographically distinct areas based on the dominant habitats and species present. These are Coatham Sands, South Gare Breakwater, Paddy's Hole and Bran Sands.

14.4.25 Coatham Sands is a 4 km expanse of exposed intertidal sandflats running from Redcar to South Gare Breakwater. Benthic ecology was found to be sparse with infaunal communities exhibiting low abundance and diversity, being characterised predominately by species associated with mobile sands. The dominant biotope in the area was 'barren or amphipod-dominated mobile sand shores' (EUNIS A2.22) which qualifies as an Annex I habitat type (mudflats and sandflats not covered by seawater at low tide).

14.4.26 South Gare Breakwater is an area of coastal protection made of rock armour which is located to the north of Coatham Sands. Paddy's Hole is an artificial bay built into the western side of South Gare Breakwater which functions as a harbour for inshore fishing vessels. The dominant biotopes found on South Gare Breakwater and at Paddy's Hole were '*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock' (EUNIS A1.113) and '*Fucus vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata' (EUNIS A1.323), respectively. Although habitats in both areas were considered representative of Annex I rocky reef (with the latter also being representative of UK habitats of principal importance under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006, as estuarine rocky habitat), they were not considered to represent high quality naturally occurring examples.

14.4.27 Bran Sands is located to the west of Coatham Sands within the mouth of the Tees Estuary. This site was characterised by homogenous intertidal muddy sandflats, typified by the biotope '*Cerastoderma edule* and polychaetes in littoral muddy sand' (EUNIS A2.242). This area was found to support more

[6] Such as the JNCC guidance for monitoring marine benthic habitats (JNCC, 2018)

complex and diverse benthic communities than the other areas sampled with species such as the common cockle (*Cerastoderma edule*) and the lugworm (*Arenicola marina*) visibly present. Infaunal communities also exhibited higher abundances, biomass, species richness and diversity compared to Coatham Sands, although the difference in the abundance and biomass of infaunal communities within these two areas were not found to be statistically significant.

14.4.28 Overall, communities were characterised by relatively low abundance, biomass, species richness and diversity. No protected species were identified during the intertidal survey. The only INNS recorded was the seaweed wakame (*Undaria pinnatifida*), which was observed sporadically in low quantities around South Gare Breakwater. The additional intertidal survey in February 2021 confirmed the results of the 2019 survey, where relatively low abundance, biomass, species richness and diversity was also recorded.

14.4.29 The results of the 2019 and 2021 intertidal surveys correspond with results of the pre-construction intertidal surveys undertaken for Teesside Offshore Windfarm in 2009 (Lancaster *et al*., 2011), where abundance and species richness was also considered to be low across the study area. These results also correspond with findings of the Marine Nature Conservation Review (MNCR) Newbiggin to Saltburn survey which was undertaken in 1993. Despite the industrialised nature of the surrounding area, chemical analysis of intertidal sediments within the Study Area showed no evidence of contaminant levels which would be expected to cause harm to benthic habitats and species. This is also consistent with historical sedimentological data which clearly indicates that sediments within the inner reaches of River Tees are more likely to be above Cefas Action Level 1 when compared with the Estuary Mouth or, especially, the Tees Bay. These findings and the wider sedimentological characterisation database surrounding the Site were discussed and confirmed with the MMO on the 26th August 2019.

Subtidal Benthic Ecology

14.4.30 Three biotopes were recorded across the 23 subtidal sampling stations. These were found to represent three spatially discrete areas characterised by distinct macrofaunal assemblages, substrata and exposure conditions. Further information is available within Figure 14-1: Benthic Study Area and Sampling Locations (ES Volume II, Document Ref. 6.3) and Figure 14-10 in Appendix 14D: Subtidal Benthic Ecology (ES Volume III, Document Ref. 6.4).

14.4.31 Stations sampled on the south bank of the River Tees, within the mouth of the estuary, were characterised by the biotope '*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud' (EUNIS A5.331). Here, conditions were found to be relatively sheltered with weak tidal streams (>1 knot) which enables the build-up of muds providing optimum habitat for the polychaete worm taxa *Nephtys* sp., in particular *Nephtys hombergii*.

14.4.32 Sampling stations out in the Tees Bay were classified as either '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (EUNIS A5.233) or '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (EUNIS A5.242). The former biotope was found in the shallow inshore area which is characterised by moderate to high exposure and sediments possessing a low clay / silt content. The latter

biotope characterised stations which were located, in most cases, in slightly deeper waters and were less exposed and exhibited a higher percentage of silt / clay.

14.4.33 Stations 6, 7, and 8 corresponded to those sampled in 2010 as part of a benthic survey undertaken for the Teesside OWF development (Entec UK Limited, 2011a) and so the biotope classifications can be compared. Biotope classifications remained consistent at stations 7 and 8. However, at station 6 an increase in mud content within sediments had led to a shift in biotope from 'infralittoral mobile clean sand with sparse fauna' (EUNIS A5.231) recorded in 2010 to '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. Given the anticipated mobility of sediment in this area, as a result of the varying levels of exposure along this coast, this change is not unexpected.

14.4.34 Two of the biotopes identified (EUNIS A5.233 and A5.242) qualify as habitats of principal importance as they are listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and belong to the UK BAP priority habitat type, 'subtidal sands and gravels'. These are also representative of the Annex I habitat 'sandbanks slightly covered by sea water all the time'. However, these habitats are not a qualifying feature of any nearby designated site. No individuals of *Sabellaria spinulosa* or reef structures were recorded at any of the subtidal benthic stations sampled in 2019.

14.4.35 Samples analysed for sediment chemistry found elevated levels of both trace metals and Polycyclic Aromatic Hydrocarbons at stations 1 and 2, in the estuary. There was little evidence to suggest the presence of wider sediment contamination within the Study Area.

14.4.36 In accordance with the Cefas guidelines for the disposal of dredged material, the localised contamination of sediments within the mouth of the Tees Estuary[7] would be unlikely to prohibit disposal to sea; this is consistent with the findings of the MMO (and their advisors Cefas) who have consented multiple dredging and disposal licences covering the area. In addition, a comparison to biological thresholds (CCME, 1999; Long *et al*., 1995) found that contamination levels were unlikely to significantly affect the benthic ecology (see Appendix 14D: Subtidal Benthic Ecology (ES Volume III, Document Ref. 6.4)) for further information). These elevated contaminants reflect the history and nature of the subtidal Study Area as a highly industrial region, with a broad variety of industries, including steelmaking and chemical manufacture, utilising land and resources within close proximity to the marine environment.

14.4.37 Despite there being evidence of localised contamination, the ecological status of macrobenthic infaunal invertebrate assemblages at station 2 and 5 were both 'High', and at station 1 the status was 'Good'. Communities classified as 'High' were generally characterised by the presence of disturbance sensitive taxa and levels of diversity and abundance associated with undisturbed conditions (Phillips *et al*., 2014). Those assigned as having a 'Good' IQI status represents habitats which are only slightly disturbed.

[7] As discussed above, the previous option for abstracting water from the River Tees was refined out during the design evolution and EIA process for the Proposed Development. An assessment of the Estuary is retained for completeness and as it forms part of the study area.

14.4.38 No species afforded conservation protection were recorded during the subtidal benthic grab surveys. Furthermore, no INNS were recorded in any of the samples.

Fish and Shellfish

14.4.39 Based on the location of the Site, the Study Area for the fisheries and fish ecology baseline has been defined as the area comprising the River Tees, the Tees Estuary, and the wider coastal area up to and including the Greater North Sea. This study area extends out to a distance of 10 km offshore from the Proposed Development Site which encompasses the relevant functional habitats and range of movement of most species found within the predicted ZoI of the Proposed Development. The Study Area falls within the MMO North East Inshore Marine Plan area and the International Council for the Exploration of the Sea (ICES) rectangle 38E8. The Study Area is within the district of the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). See Figure 14B-1: Study area for the fisheries and fish ecology baseline in Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4) for the location of the fisheries and fish ecology Study Area.

14.4.40 The River Tees and Estuary is an important water body for diadromous fish species which make seasonal migrations between the sea and riverine environment. Salmon, sea trout, European eel, river lamprey and sea lamprey are all known to be present and have been identified as Local Priority Species within the Tees Valley BAP.

14.4.41 The River Tees is designated as one of the 64 main salmon rivers in England and Wales. There is currently a Salmon Action Plan in force which aims to manage the performance of salmon stocks within the River Tees against conservation limits (CL) (Cefas *et al*., 2019). The River Tees has been subject to historic pollution and is therefore recovering; however it does support a small and increasing salmon and sea trout rod river fishery (Environment Agency, 2009a). The River Tees is not achieving its current CL which has been identified as an annual production of 14.9 million eggs[8]. Whilst this is expected for a river in the recovery phase, it is projected that in 2021, the Tees will remain at risk of not complying with salmon management objectives reported by ICES (Environment Agency, 2018).

14.4.42 The key migratory period for salmon and sea trout includes much of the spring, summer and autumn months (Thorstad *et al*., 2012; Cowx and Fraser, 2003). Typically smolts migrate downstream in spring and early summer, whilst adults return to upstream habitats between June to August or October to December. Spring and autumn are key periods for migrating European eel and sea lamprey (Chadwick *et al*., 2007; Righton *et al*., 2016; Laughton and Burns, 2003) whilst river lamprey exhibit a protracted migratory period extending from mid-summer (July) through to the end of autumn (December) (Natural England, 2010).

14.4.43 Estuarine and marine fish communities within the vicinity of the Site represent a mixed demersal and pelagic fish assemblage typical of the central North Sea (Environment Agency, 2019d). Within the lower reaches of the River Tees and

[8] This is the target number of eggs deposited during spawning to ensure the status of the population remains favourable.

coastal waters, species such as sprat (*Sprattus sprattus*), herring (*Clupea harengus*), plaice (*Pleuronectes platessa*) and lesser sand eel (*Ammodytes tobianus*) are most prevalent. Assemblages offshore are characterised by herring, Atlantic mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), plaice, and dab (*Limanda limanda*) (Teal, 2011; Callaway *et al*., 2002).

14.4.44 Common shellfish species within inshore waters include edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and velvet swimming crab (*Necora puber*) whilst the Dublin Bay prawn, *Nephrops norvegicus* commonly occurs offshore (Entec UK Limited, 2011b). There are no designated shellfish waters within the vicinity of the Site, with the nearest one located at Holy Island of the Northumberland coast over 120 km away.

14.4.45 Fisheries sensitivity maps (Coull *et al*., 1998; Ellis *et al*., 2012) indicate that the Site is located within the nursery grounds of the following species: herring, sprat, cod, whiting, plaice, *Nephrops*, lemon sole (*Microstomus kitt*) and spurdog (*Squalus acanthias*). The Proposed Development is also found within the spawning area of lemon sole and *Nephrops*.

14.4.46 Within ICES rectangle 38E8, demersal otter trawling, and seine netting are the most prevalent fishing methods, targeting predominately *Nephrops* and whiting (MMO, 2018b). Potting and trapping for lobster, edible crab, velvet swimming crab, *Nephrops* and cod also commonly occurs.

14.4.47 Further information related to the fisheries and fish ecology baseline can be found in Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4).

Commercial Fisheries

14.4.48 The Study Area for commercial fisheries aligns with that used for the fish and shellfish baseline study area for the Proposed Development and set out at 4.4.39 above. Within this area, the commercial fishing activity of relevance comes from the ICES rectangle 38E8. Information on commercial fishing activity in this rectangle has come from data reported by the MMO (2018b), as part of the iFISH data system. Additional information on commercial fishing activity has come from the Automatic Identification System (AIS) on UK vessels 15 m and over, as reported by the MMO (2018c).

14.4.49 Consultation with the NEIFCA has been undertaken, clarifying that all available data sources have been referenced as part of this baseline study (Smith, pers. comms., 2021). This discussion highlighted that the resolution for commercial fishing activity, for vessels under 10 m, was limited to the ICES rectangle 38E8. However, comment was provided on fishing activity in the Tees Bay, stating that limited potting and trapping was likely to take place, with very small numbers of local fishing vessels (under 10 m) utilising this area.

14.4.50 Vessels fishing in ICES rectangle 38E8 were all registered in the United Kingdom (UK)[9], with the majority of annual landings being made by English vessels (average landed weight from 2013 – 2017 was 1,018 tonnes). Vessels registered with a home port status of Hartlepool include 24 vessels of under

[9] Foreign nationalities are not required to report landings data via iFISH.

10 m and 2 vessels of 10 m and over (MMO, 2021a; MMO, 2021b). Twenty of the 10 m and under vessels hold active shellfish licences. None of the 10 m and over vessels holds a shellfish licence and none of these vessels holds a scallop licence.

14.4.51 Discussions with NEIFCA highlighted that local fishing vessels would also be docked at Paddy's Hole, South Gare and along the Redcar Promenade, Coatham, registered with home port status in Redcar (Smith, pers. comms., 2021). Overall, there were 28 vessels of 10 m and under registered with home port status in Redcar, all of which hold shellfish licences but not scallop licences (MMO, 2021a). No vessels 10 m and over were registered with home port status in Redcar (MMO, 2021b).

14.4.52 The highest density of vessels were found within the navigational channel in the estuary and to the north east, which represents the primary routes of commercial vessels leaving Teesport. Further information regarding commercial vessels and fishing activity is provided within Chapter 20: Socio-economics (ES Volume I, Document Ref. 6.2) and Figures 20B-1 and Figure 20B-2(ES Volume II, Document Ref. 6.3). Directly to the east of the estuary mouth and South Gare, vessel densities are much lower as this area is predominately non-navigable for larger vessels.

14.4.53 In the ICES rectangle 38E8 demersal otter trawling and seine netting were the most prevalent fishing methods (total landed weight of fish and shellfish of 4,369 tonnes reported from 2013 – 2017), targeting predominantly *Nephrops* and whiting. The second most common fishing method in this rectangle was potting and trapping (total landed weight of 1,219 tonnes reported from 2013 – 2017), used to target mainly lobsters and edible crabs. Beam trawling, scallop dredging, drift and fixed netting, and gear using hooks, only represented a combined total of 2% of landed weight (tonnes), with scallops representing 88% of the total landed weight recorded for the scallop dredging fishing method.

14.4.54 Vessels of 10 m and under in the ICES rectangle 38E8 undertook a larger proportion of potting and trapping, which targets edible crabs and lobsters. However, demersal trawling and seine netting remains the dominant fishing technique for all vessels in this rectangle.

14.4.55 Further information related to the commercial fisheries baseline can be found in Appendix 14B: Fisheries and Fish Ecology Baseline (ES Volume III, Document Ref. 6.4).

Marine Mammals

14.4.56 The Study Area for marine mammals encompasses the lower reaches of the River Tees and the coastal waters around the entrance to the Estuary and to the south, between South Gare and around Coatham Rocks. However, recognising the highly mobile and transient nature of marine mammals and the potential implications of local impacts on wider populations, the Study Area also includes the Greater North Sea Ecoregion (North Sea, English Channel, Skagerrak and Kattegat) but with a focus on the ICES Division IVb. This extent also takes into consideration (where available) species-specific Management Units published by the Inter Agency Marine Mammal Working Group (IAMMWG) (IAMMWG, 2015). See Figure 14C-1: Immediate and wider Study

Area for the marine mammal baseline in Appendix 14C: Marine Mammal Ecology Baseline (ES Volume III, Document Ref. 6.4) for the location of the marine mammal Study Area.

14.4.57 Within the Greater North Sea Ecoregion, four cetacean species occur regularly or are resident including harbour porpoise (*Phocoena phocoena*), minke whale (*Baleanoptera acutorostrata*), bottlenose dolphin (*Tursiops truncates)* and white-beaked dolphin (*Lagenorhynchus albirostris*) (ICES, 2019). Two seal species live and breed in UK waters: grey seal and harbour (or common) seal (SCOS, 2018).

14.4.58 The North Sea and coastal waters around the Site are known to be important for harbour porpoise. However, they are of comparatively low or very low importance for white-beaked dolphin and bottlenose dolphin respectively (Hammond *et al*., 2017). Although minke whale are not thought to occur in shallow coastal waters within the immediate vicinity of the Site, the northern North Sea is of importance for this species. All four cetacean species are recognised as being of 'favourable' conservation status (Joint Nature Conservation Council (JNCC), 2019a) and of 'least concern' globally (IUCN, 2019).

14.4.59 The immediate area around the Site is of local importance for harbour seal due to the presence of a breeding colony at Seal Sands. This area is also a haul-out site for grey seal. Seal Sands typically supports 100 – 140 harbour seals and 40 grey seals during the summer period (INCA, 2019). The mean number of grey seals recorded by the Industry Nature Conservation Association (INCA) across all sampling months was lower in 2019 compared to previous years (e.g. 2014, 2016 and 2017) although remained high compared to pre-2010 counts (INCA, 2019).

14.4.60 Surveys carried out by the INCA in 2019 observed a record number of harbour seal pups and adults in Teesmouth. However, whilst no pup deaths were recorded during the INCA monitoring period (i.e. when pups are dependent on their mother), unrecorded levels of mortality were observed by the British Divers Marine Life Rescue in the succeeding months (INCA, 2019). Most deaths were linked to an unknown infection.

14.4.61 Further haul-out sites are located at Greatham Creek and Bailey Bridge approximately 1.6 km and 0.9 km away from the proposed Site boundary, respectively. These sites are predominately used by harbour seals for breeding and moulting. Per year, an average of 18 harbour seals have been observed at Greatham Creek in August, between 2010 and 2019, whilst the mean abundance observed at Bailey Bridge in 2019 was less than six individuals (INCA, 2019). Grey seals are also known to haul out at Greatham Creek on occasion but again in low abundance (typically less than 10 individuals). Grey seals were not observed hauling out at Bailey Bridge during the 2019 survey (INCA, 2019).

14.4.62 Tagging and observational studies have shown that, despite a local presence, the coastal waters around the Site (i.e. within ~50 km) are not heavily used by either seal species (Russell *et al*., 2017). Whilst grey seal is considered to be of 'favourable' conservation status in the UK, harbour seal is 'unfavourable – inadequate' (JNCC, 2019a). However, globally both species are considered to be of 'least concern' (IUCN, 2019).

14.4.63 As outlined in paragraph 14.4.6, the Site and the main Study Area (i.e. within a radius of 10 km from the Site) does not overlap with any European Sites or MCZs designated for marine species, including marine mammals. However, four SACs located in the wider North Sea (between 86 km and 211 km from the Site) are designated for marine mammal species including grey seal (Berwickshire and Northumberland SAC and Humber Estuary), harbour seal (The Wash and North Norfolk Coast) and harbour porpoise (Southern North Sea SAC).

14.4.64 Recognising the importance of the Study Area for harbour porpoise and the potential connectivity to the Southern North Sea SAC, this designated site has been considered within the assessment presented in Section 14.6: Likely Impacts and Effects and also within the Habitat Regulations Assessment Report (Document Ref. 5.13) which is provided with the Application.

14.4.65 Tagging and observational studies have shown little interaction between harbour seal which occur in the Teesmouth and SAC populations within the wider North Sea. Furthermore, although interactions between major grey seal colonies are known, individuals have been observed to migrate offshore (>50 km) well beyond the ZoI of the Proposed Development (Russell *et al*., 2019). Thus, all the sites listed in paragraph 14.4.63 which are designated for seals have been scoped out from the assessment presented in Section 14.6: Likely Impacts and Effects.

14.4.66 Further information related to the marine mammal baseline can be found in Appendix 14C: Marine Mammal Ecology Baseline (ES Volume III, Document Ref. 6.4).

Summary of Receptors

14.4.67 In accordance with the methodology outlined in Section 14.3: Assessment Methodology and Significance Criteria, Table 14-5 summarises the receptors relevant to the assessment of marine ecology for the Proposed Development and their ecological importance.

Table 14-5: Summary of the Importance of Marine Ecological Receptors

Receptor group	Description	Justification	Importance rating
Designated Sites	Teesmouth and Cleveland Coast SPA / Ramsar / SSSI and Southern North Sea SAC	Designated sites of international importance	Very High
Plankton	Phytoplankton and Zooplankton	No protected species and communities common and widespread	Low
Intertidal habitats and communities	Includes sand and mudflats and rocky shore*	Presence of Annex I habitats which are not a qualifying feature of any nearby designated site	Medium
Subtidal habitats and communities	Includes all subtidal habitats and non-commercial invertebrate species	Presence of Annex I habitats which are not a qualifying feature of any nearby designated site	Medium
Fish and shellfish	Migratory fish species (including Atlantic salmon, European eel, sea trout and lamprey)	Internationally protected species threatened throughout their range (European eel 'critically endangered' according to IUCN Red List)	Very High
	Commercial fish and shellfish species	Species present which are of high importance to commercial fisheries	High
	General fish and shellfish	Presence of protected species (not a qualifying feature of a nearby designated site, but listed under Section 41 of the NERC Act 2006 and in the OSPAR list of threatened and / or declining species for the North-East Atlantic) with nearby nursery and spawning grounds	Medium
Marine mammals	Cetaceans and pinnipeds	Internationally protected species which are qualifying features of nearby designated sites	Very High

* Other coastal habitats including reedbeds, coastal marsh, saline lagoons, sand dune and maritime cliffs and slopes are covered by terrestrial and aquatic ecology (Chapter 12 and 13, respectively).

Future Baseline

14.4.68 The River Tees and Estuary has had a long industrial and urbanised history during which time disturbance to the marine environment has been high. Historically, human activities have led to range of impacts including increased water pollution and reduced access to upstream environments which have

resulted in several well documented ecological effects including a decline in the abundance of migratory fish species and seals within the Tees Estuary (Cefas *et al*., 2019; INCA, 2019).

14.4.69 In recent years, conservation and management efforts have seen an improvement in environment conditions and a recovery in species populations. Trends for several species such as harbour seal are generally increasing (INCA, 2019), whilst for others such as Atlantic salmon, populations remain at risk (Cefas *et al*., 2019). Future management measures (e.g. continued improvements in water quality, removal of instream barriers and the installation of fish passes and screening at intakes) can be expected to facilitate improvements in species populations although it is not possible to quantify the future benefits of such measures.

14.4.70 Other factors which pose a risk to marine ecological receptors include the prevalence of disease and climate change. Outbreaks of phocine distemper virus can lead to mass mortality of seals. In 2019, unprecedented levels of seal pup mortality were observed in the Study Area and although no specific cause was identified, individuals displayed similar symptoms which indicated some type of infection (INCA, 2019).

14.4.71 Future UK Climate Projections 2018 (UKCP18) from the Met Office for the Stockton-on-Tees area (The Met Office, 2019), based on a 1981 – 2000 baseline[10], uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform different future emission trends. RCP 8.5 has been used for the purposes of this assessment as a worst-case scenario.

14.4.72 Based on RCP 8.5, there is a 50% probability that sea levels will have risen 8 cm by 2022 (i.e. commencement of construction) and 11 cm by 2026 (i.e. commencement of operation). By 2051 (i.e. the end of the Proposed Developments operational lifespan) this may increase further to 26 cm above 1981 – 2000 baseline.

14.4.73 Sea temperature change projections are more variable and less specific to the Teesside region. Under RCP 8.5 a rise in global sea surface temperatures of 1.5°C by 2050 is predicted, increasing to a 3.2°C rise by 2100 relative to 1870 – 1899 temperatures. In UK waters, mean annual sea temperatures have risen by 0.8°C since 1870 and have continued to show consistent warming trends since the 1970s onwards (Genner *et al*., 2017).

14.4.74 Changes in sea level can lead to shifts in the abundance, extent and distribution of habitats and species. Increased sea temperatures can also lead to changes in species abundance and distribution as well as life history processes including growth and reproduction.

14.4.75 Based on the climate change predictions outlined above, and the characteristics of the coastal environment within the vicinity of the Site (i.e. relatively low lying), there is potential for the extent and distribution of habitats to change up until commencement of operation in 2026. For example, an 11 cm increase in sea level in 2026 would subject the area to coastal squeeze resulting in a loss of mudflat and sandflat habitats, a landward shift in the

[10] This baseline has been selected as it provides projections for 20-year time periods (e.g. 2020 – 2039).

distribution of intertidal habitats and an extension of subtidal habitats. As a consequence, functional habitats for fish and shellfish may expand and seals may be vulnerable to a loss of suitable haul-out areas within Seal Sands and the wider Tees Estuary.

14.4.76 The predicted increase in sea temperature is unlikely to result in detectable shifts in the abundance, distribution and life history characteristics of species (e.g. infaunal species, fish, shellfish and marine mammals) within the vicinity of the Site prior to approximate commencement of operation of the Proposed Development (2026). However, unpredictable changes to seal populations due to, for example, a sudden outbreak of disease during this time, cannot be ruled out.

14.4.77 Further changes may be observed during the operational lifetime of the Proposed Development (approximately 25 years for the Low Carbon Electricity Generating Station and over 40 years for the CO_2 Gathering Network and HP Compressor) which may affect baseline conditions at the point of decommissioning. Prior to decommissioning, a Decommissioning Environment Management Plan (DEMP) will be developed and agreed with the Environment Agency and other stakeholders as part of the site surrender process. This shall consider in detail all potential environmental risks of the Site and would be expected to consider baseline conditions at that time; further details associated with the decommissioning process and relevant environmental safeguards are provided within Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2)

14.5 Development Design and Impact Avoidance

14.5.1 The design process for the Proposed Development has included consideration of ecological constraints and has incorporated, where possible, measures to reduce the potential for adverse ecological effects, in accordance with the mitigation hierarchy and relevant planning policy.

14.5.2 The measures identified and adopted include those that are inherent to the design of the Proposed Development, and those that can realistically be expected to be applied as part of environmental best practice, or as a result of legislative requirements.

14.5.3 A Construction Environmental Management Plan (CEMP) and Site Waste Management Plan (SWMP) shall be prepared and implemented by the Contractors. These documents are intended to secure all good practice and mitigation measures to be executed during the construction phase in order to control and minimise impacts on the environment. The submission, approval and implementation of these controls will be secured through a Requirement of the draft DCO. A Framework CEMP is included in Appendix 5A of the ES (ES Volume III, Document Ref. 6.4), which accompanies the Application and sets out the key measures to be employed during the main works phase to control and minimise the impacts on the environment. The Final CEMP will be prepared by the Contractors in accordance with the Framework CEMP.

14.5.4 The following measures are specifically intended to avoid and / or reduce impacts to marine ecology and relevant designated sites during the construction and operational phases of the Proposed Development. The

measures proposed have taken into the considered the worst-case scenarios presented in Table 14-1.

14.5.5 Furthermore, these measures have taken into consideration the River Tees SAP priorities which are relevant to the project, including the impact pathways of the Proposed Development to the marine environment (including on marine water quality and the passage of fish). These good practice and design mitigation measures are intended to minimise the impacts of the Proposed Development and avoid deterioration in the quality of the marine environment and its ecological receptors.

To Avoid and / or Reduce Direct Loss and Physical Disturbance to Marine Ecology

14.5.6 Should the Proposed Development re-use, refurbish or replace the existing outfall (Water Discharge Connection Corridor) from the former Redcar Steelworks it shall be carried out where practicable to minimise land-take and the subsequent loss of benthic habitats and species, as well as to reduce disturbance to other marine ecological receptors.

14.5.7 Construction of the CO_2 Export Pipeline shall be carried out where practicable to minimise land-take and the subsequent loss of benthic habitats and species, as well as to reduce disturbance to other marine ecological receptors.

14.5.8 Trenchless technologies shall be used to install the gas connection (if required) and the pipework for the CO_2 Gathering Network across the River Tees in order to minimise disturbance to riverine habitats and species.

14.5.9 Trenchless technologies shall be used to install the CO_2 Export Pipeline and Water Discharge Corridor across the foreshore to minimise disturbance to benthic habitats and species.

14.5.10 All project vessels shall adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments with the aim of preventing the spread of marine INNS (IMO, 2017).

14.5.11 All project vessels shall adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines) (IMO, 2011).

To Avoid and / or Reduce Underwater Sound and Visual Disturbance

14.5.12 Construction working hours will generally be Monday to Friday 07:00 to 19:00 and Saturday 07:00 to 13:00 thereby offering marine ecological receptors respite from any disturbance. However, some construction activities that cannot be interrupted, such as concrete pouring and certain specialist crossing activities such as HDD and MBT operations (which produce continuous sound sources only), are likely to continue outside the general working hours and may operate 24 hours a day at certain times.

14.5.13 Activities that generate impulsive underwater sound within the marine environment (i.e. geophysical survey works and UXO detonation) shall not be undertaken at night.

14.5.14 The standard JNCC mitigation measures for explosives and geophysical surveys (JNCC, 2010; JNCC, 2017) shall be adopted during construction of the Proposed Development as appropriate.

14.5.15 An assessment of the impact of detonation will be done at the time of discovering UXO with a requirement for a seasonal restriction where noise abatement measures cannot bring the effect down to non-significant. This assessment, and any necessary mitigation, will be secured through conditions included on the draft DML associated with UXO disposal; a draft DML is provided with the Application in the draft DCO (Document Ref. 2.1).

14.5.16 Construction and operational lighting will be arranged so that glare and light spill outside the construction site is minimised to avoid impacts to sensitive ecological features. An Indicative Lighting Strategy (Document Ref. 5.11) has been prepared to accompany the DCO Application to demonstrate how lighting impacts on sensitive ecological features.

To Avoid and / or Reduce Changes to Marine Water Quality

Construction Phase

14.5.17 Within the CEMP there will be a Water Management Plan (WMP) that sets out the principles that shall be adhered to in order to manage the risk of water pollution. These overriding principles include:

- standard best practice prevention measures will be applied for the prevention water pollution, fugitive dust management and noise prevention or amelioration;
- all works will be subject to any conditions applied to the DCO and/or DML in relation to water quality;
- details of relevant guidance for operations, including the latest Pollution Prevention Guidance[11] as well as other relevant good practice guidance intended to protect the water environment (see Section 9.5 in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2) for further information); and
- requirements for relevant staff training in environmental awareness, pollution prevention and pollution response protocols.

14.5.18 The outline WMP will also describe in greater detail the range of measures that could be adopted by the Contractor(s) when undertaking the works in accordance with these environmental protection principles. These measures broadly focus on:

- managing the risk of construction site runoff or dewatering containing high levels of fine sediment or contaminants;
- implementing measures to control the storage, handling and disposal of potentially polluting substances during construction;
- managing activities adjacent to and within waterbodies (both freshwater, estuarine and marine) to avoid, minimise and reduce water pollution,

[11] http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

unacceptable physical damage, potential ecological impacts, and disruption to third parties; and

- ensuring there is adequate emergency response equipment, training and planning for all possible incidents.

14.5.19 Specific mitigation measures related to the management of construction site runoff, spillage risk and the dispersion of suspended sediments are outlined in Section 9.4 of Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2). Briefly, these include measures such as:

- implementation of a temporary drainage system during the construction phase to prevent contaminated surface water run-off from entering the marine environment;
- safe and secure storage of flammable / toxic / corrosive materials within bunded and fenced off areas;
- all refuelling, oiling and greasing to take place above drip trays or on an impermeable surface;
- provision of wash down facilities for vehicles and equipment;
- preparation of a Pollution Prevention Plan to be included alongside the final CEMP; and
- where dredging and disposal is required, pre-construction sediment contamination testing shall be carried out in consultation with the MMO to identify whether there is potential for direct effects to marine water quality. This shall be conducted in accordance with the MMO's Sample Plan and subsequent Sample Analysis ('SAM') process and is anticipated to be secured via condition of the Draft DML.

14.5.20 All Project vessels shall comply with the International Regulations for Preventing Collisions at Sea (IMO, 1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (IMO, 2021) with the aim of preventing and minimising pollution from ships. Most critically, all vessels shall have a contingency plan for marine oil pollution (Shipboard Oil Pollution Emergency Plan).

14.5.21 Should any dredging be required (e.g. for the placement of the new discharge head and diffuser associated with the outfall within the Water Discharge Connection Corridor) it is anticipated that material shall either be either displaced alongside the replacement outfall head using plough dredger or similar and retained / re-used within the Site or disposed of at a licenced marine site.

14.5.22 Exact requirements for the licenced marine site have yet to be formally confirmed but there are several options in close proximity to the Site; this includes the existing Teesside A (TY 160) and Teesside C (TY 150) which are known to regularly receive material similar to that which is likely at the proposed dredge locations. Disposal of dredged material would be undertaken in accordance with the conditions of a Marine Licence from the MMO; for dredging and disposal specifically, this includes physical and/or chemical analysis under the MMO's Sample Plan and subsequent Sample Analysis

('SAM') process. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; a DML is provided with the Application in the draft DCO (Document Ref. 2.1).

Operational Phase

14.5.23 A formal drainage strategy will be developed for the operational phase of the Proposed Development. This will include a suitable surface water drainage network (i.e. compliant Sustainable Drainage System (SuDS)) which will capture surface water run-off for processing on site before being discharged to the Tees Bay via the outfall within the Water Discharge Connection Corridor.

14.5.24 A Surface Water Maintenance and Management Plan shall also be developed detailing information relating to access and maintenance of the different SuDS and surface water features proposed on the Site.

14.5.25 A site Emergency Response Plan shall be produced for the operational phase to deal with emergency situations involving loss of containment of any hazardous substances. Key actions which shall be included within this plan are outlined in Section 9.5 of Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

14.5.26 Treated effluent from the Proposed Development will be discharged in accordance with the relevant conditions of an Environmental Permit and in compliance with the relevant Equivalent Quality Standards (EQSs) (see Appendix 9F, ES Volume III, Document Ref. 6.4). Technical engagement with the Environment Agency has been undertaken to confirm this position and screen-out the requirement for further analysis for the ES (i.e. on the basis that the monitoring and control of treated effluent is suitably addressed via the Environmental Permitting regime).

14.5.27 Sampling of treated water shall be undertaken prior to discharge to ensure compliance with Environmental Permitting requirements during the construction and operational phases of the Proposed Development. The frequency of sampling shall be agreed with the permitting authority.

14.6 Likely Impacts and Effects

14.6.1 This section describes the likely impacts and potential effects of construction, operation (including maintenance), and decommissioning of the Proposed Development on marine ecological receptors in the absence of any mitigation, over and above that which is inherent to the design and good practice (as described in Section 14.5: Development Design and Impact Avoidance).

14.6.2 To enable a focussed impact assessment, a scoping exercise has been undertaken to identify the potential impacts of the Proposed Development that are likely to result in adverse or beneficial effects on marine ecology and which require further impact assessment below (see EIA Scoping Report, Appendix 1A, ES Volume III, Document Ref. 6.4).

14.6.3 The following activities are considered unlikely to result in any impact to marine ecology and have therefore been scoped out from requiring further consideration within Section 14.6: Likely Impacts and Effects.

- a ‘no dig’ construction method using trenchless technologies shall be used to construct the gas connection and CO_2 Gathering Network across the River Tees. There is no pathway for impact to marine ecological receptors from either of these options as the works would be underground with breakout points below MHWS;
- the quality of any effluent discharged to the marine environment will comply with the Environmental Permit for operational activities;
- during the operational phase, domestic and sanitary waste from the Proposed Development will be piped off-site to the Marske-by-the-Sea Sewage Treatment Works (STW) where it will be adequately treated before being discharged, complying with Northumbrian Water’s environmental discharge permit. As outlined in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2), the impact to WFD water bodies is predicted to be not significant and thus, there is considered to be no pathway for impact to marine ecological receptors;
- in light of the in-built mitigation proposed (summarised in paragraphs 14.5.23 to 14.5.26 but described in full within Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2), the risk of impacts to WFD water bodies from routine surface water run-off and accidental spillages during the operational phase are predicted to be negligible. Thus, there is considered to be no pathway for impacts to marine ecological receptors.

14.6.4 During the design evolution and EIA process, a series of design changes for the Proposed Development have been made. The following changes are of primary relevance to marine ecology:

- **Water Supply:** the option of using the existing former steelworks abstraction point intake on the south bank of the River Tees was considered up to (and during) Stage II consultation. There is no longer the requirement to abstract water from the River Tees using the existing infrastructure as cooling water will be supplied by Northumbrian Water. As such, the potential impact and effects as a result of the entrapment of marine organisms within the Cooling Water System (CWS) is no longer considered as part of the Proposed Development; and
- **Replacement Outfall / CO_2 Export Pipeline**: the potential construction of the replacement outfall and CO_2 Export Pipeline using open-cut methods through Coatham Sands and through the Tees Bay foreshore was considered up to (and during) Stage II consultation. The use of open-cut methods is no longer being considered.

14.6.5 Further details surrounding the evolution of the Proposed Development are provided within Chapter 6: Consideration of Alternatives (ES Volume I, Document Ref. 6.2).

14.6.6 For example, there is no longer the requirement to abstract water from the River Tees using the existing infrastructure. As such, the potential impact and effects as a result of the entrapment of marine organisms within the CWS is no longer considered as part of the Proposed Development.

14.6.7 The likely impacts and effects of construction and operation of the Proposed Development on marine ecological receptors, that have been scoped in for consideration within this ES chapter are summarised in Table 14-6 below (for approach to scoping see EIA Scoping Report, Appendix 1A, ES Volume III, Document Ref. 6.4). Table 14-6 includes reference to the relevant paragraph numbers where these impacts from potential effects are assessed.

14.6.8 The likely impacts and effects of the decommissioning phase are considered further in paragraphs 14.6.249 onwards.

Table 14-6: Summary of Construction and Operation Likely Impacts and Effects and Marine Ecological Receptors

Likely Impacts	Designated sites	Plankton	Intertidal habitats and communities (Appendix 14A)	Subtidal habitats and communities (Appendix 14D)	Fish and shellfish (Appendix 14B)	Commercial Fisheries (Appendix 14B)	Marine mammals (Appendix 14C)
Construction Phase							
Direct Loss and Physical Disturbance to Habitat and Species Under the Footprint of the Marine Construction Works (paragraph: 14.6.10)	✓			✓	✓		✓
Physical Disturbance to Benthic Habitats and Species from Increased Suspended Sediment Concentrations (i.e. Turbidity) and Deposition (paragraph: 14.6.32)	✓			✓	✓		✓
Indirect Effects to Marine Ecology from Changes in Marine Water Quality (excluding Turbidity) (paragraph: 14.6.53)	✓	✓	✓	✓	✓		✓
Changes in Underwater Soundscape (paragraph: 14.6.64)	✓				✓		✓
Changes in the Airborne Soundscape During Construction (paragraph: 14.6.133)	✓						✓
Changes in Visual Stimuli (Including Artificial Light) (paragraph: 14.6.145)	✓				✓		✓
Introduction and Spread of Invasive Non-Native Species (paragraph: 14.6.156)	✓	✓	✓	✓	✓		✓

Likely Impacts	Designated sites	Plankton	Intertidal habitats and communities (Appendix 14A)	Subtidal habitats and communities (Appendix 14D)	Fish and shellfish (Appendix 14B)	Commercial Fisheries (Appendix 14B)	Marine mammals (Appendix 14C)
Collisions Between Project Vessels and Marine Mammals (paragraph: 14.6.161)							✓
Loss or restricted access to commercial fishing grounds (paragraph: 14.6.170)						✓	
Displacement of commercial fishing activities (paragraph: 14.6.176)						✓	
Obstruction of navigation / steaming routes to commercial fishing grounds (paragraph: 14.6.177)						✓	
Indirect effects on commercial fish and shellfish species (paragraph: 14.6.181)						✓	
Operation Phase							
Thermal Effects from Treated Water Discharge (paragraph: 14.6.183)	✓	✓	✓	✓	✓		✓
Chemical Effects from Treated Effluent Discharge (paragraph: 14.6.223)	✓	✓	✓	✓	✓		✓
Effects to Intertidal Habitats and Species (Including Fish) From the Deposition of Airborne Pollutants (paragraph: 14.6.229)			✓		✓		

Likely Impacts	Designated sites	Plankton	Intertidal habitats and communities (Appendix 14A)	Subtidal habitats and communities (Appendix 14D)	Fish and shellfish (Appendix 14B)	Commercial Fisheries (Appendix 14B)	Marine mammals (Appendix 14C)
Changes in the Airborne Soundscape During Operation (paragraph: 14.6.234)	✓						✓
Loss of commercial fishing grounds (paragraph: paragraph 14.6.243)						✓	
Displacement of commercial fishing grounds (paragraph: 14.6.247)						✓	

Construction Phase

14.6.9 The following sections consider the way in which construction of the Proposed Development has the potential to impact marine ecological receptors.

Direct Loss and Physical Disturbance to Habitat and Species Under the Footprint of the Marine Construction Works

14.6.10 Several construction activities have the potential to result in the direct loss and physical disturbance of marine habitats and species. These include:

- creation of a break-out point for the subtidal for the installation of the replacement outfall using micro-bore tunnelling;
- preparatory dredging for emplacement of a new outfall head for both the existing and replacement outfall scenarios;
- the installation of rock armouring / scour protection around the new outfall head for either the existing or the replacement outfall; and
- anchoring, grounding or positioning of work boat(s) and / or barge(s) on the seabed to support the refurbishment works of the existing outfall.

14.6.11 The majority of these activities are expected to have a temporary impact, each occurring only once and lasting for only a short period of time during the construction phase. Based on the current indicative construction programme, works associated with the Tees Bay and Dunes/Foreshore Crossings (which includes the construction of the Water Discharge Connection) would last for around nine months. The only exceptions, which would result in permanent loss of subtidal seabed habitat, are the creation of a breakout point where the Micro-Bored Tunnel (MBT) emerges within the subtidal area of the Tees Bay, the emplacement of the new outfall head and the installation of the associated rock armouring / scour protection. The exact footprint of the temporary and permanent marine construction works is still to be established pending detailed design of the Proposed Development, and thus a worst-case scenario has been assumed for the purpose of this assessment.

14.6.12 The new rock armour could have the capacity to function as an artificial rocky reef, providing new colonisation opportunities for species dependant on hard substrate, in an otherwise sediment type seabed. Beneficial effects to benthic ecology, mobile invertebrates and fish are considered in further detail below. However, the introduction of hard artificial substrates in areas otherwise characterised by sandy mobile substrates also has the potential to facilitate the establishment and spread of INNS leading to adverse effects to marine ecology – this is discussed in paragraph 14.6.157.

14.6.13 For both the replacement outfall and the CO_2 Export Pipeline, trenchless technologies will be used, consisting of micro-bore tunnelling and a number of HDD bores, respectively. Thus, there will be no direct loss of intertidal habitats and their associated infaunal and epifaunal communities under the footprint of the marine construction activities for the outfall and CO_2 Export Pipeline. Therefore, effects to intertidal benthic ecology have not been considered further for this impact pathway.

Subtidal Habitats and Communities

14.6.14 Subtidal benthic habitats and their associated infaunal and epifaunal communities will be directly lost under the footprint of the marine construction activities. This could lead to fragmentation of habitats and a loss of ecosystem services provided by these habitats.

14.6.15 Any habitat can be regarded as intolerant of permanent loss. However, soft sediment habitats, such as those which characterise much of the footprint of the marine construction works are, according to the Marine Life Information Network's (MarLIN) Marine Evidence Based Sensitivity Assessment (MARESA)[12], known to be highly resilient to direct physical disturbance arising from substrate loss (e.g. from dredging) and penetration (e.g. from anchoring or grounding of vessels). Overall, subtidal benthic ecology would have medium sensitivity to direct loss and physical disturbance.

14.6.16 Although the exact extent of temporary and permanent habitat loss is still to be established, based on the worst-case scenarios described above, there is predicted to be habitat loss within the subtidal zone. This would affect subtidal sandflats which qualify as habitats of principal importance being listed under Section 41 of the NERC Act 2006 and are representative of the Annex I habitat H1110 'Sandbanks which are slightly covered by sea water all the time'.

14.6.17 Temporary loss and physical disturbance of subtidal habitats considered to be representative of Annex I habitats would occur during the construction phase, as a result of anchoring, grounding or positioning of marine vessels. Overall, the area this would represent is considered to be negligible and the spatial extent would be highly localised. It is anticipated that any habitat lost would recover over reasonable timescales (i.e. <5 years), following completion of construction as the habitats known to be present are well adapted to regular natural disturbance from, for example, storm events.

14.6.18 Boring of the MBT will be used to create a replacement discharge pipeline, which will run from the PCC Site to the discharge point within the Tees Bay, located approximately 2 km offshore, within the Site boundary. It anticipated that permanent habitat loss within the subtidal would occur at the break-out point, where the MBT emerges. To accommodate the discharge pipeline (which will consist of a tunnel 2 m in diameter), the break-out point will be <3 m in diameter. At either the replacement outfall or the existing outfall, a new outfall head and diffuser will be installed, with the positioning of rock armouring and scour protection around the outfall head. It is expected that permanent subtidal habitat loss would occur under the footprint of these.

14.6.19 The subtidal area at both the existing and the replacement outfall locations is characterised by two biotopes (EUNIS A5.233 and A5.242), which represent the habitat 'subtidal sands and gravels', and qualify as qualify as habitats of principal importance being listed under Section 41 of the NERC Act 2006 and as Annex I habitat 'sandbanks slightly covered by sea water all the time'. The exact volume of rock armouring required for the protection of a replacement outfall head, assuming a worst-case, is estimated to be approximately 250 m^3. With the inclusion of the outfall head (which would encompass the MBT break-out point), this has been estimated (using precautionary dimensions of 10 m

[12] https://www.marlin.ac.uk/

x 10 m) to represent an area of 100 m^2, where a permanent loss of Annex I subtidal sandflat habitat would occur. If the outfall head is to be replaced at the existing outfall infrastructure, the new outfall head will be located where permanent habitat loss has already occurred. Therefore, in this scenario no significant additional habitat loss is expected.

14.6.20 However, the rock armouring presents a significant surface area for colonisation by flora (e.g. algae) and fauna (e.g. barnacles, tube worms, sea squirts and soft corals such as *Alcyonium digitatum*). Following placement and during the remaining construction phase and into the operational phase, a succession in the benthic communities associated with this structure is likely to be observed, transitioning from early colonisers (e.g. diatoms, filamentous algae and barnacles) to a climax community. In terms of biomass, this newly available food resource can be expected to offset to some extent the loss of infauna habitats (Langhamer, 2012).

14.6.21 Whilst construction of the Proposed Development can be expected to alter the extent, distribution and structure of subtidal habitats and communities under the footprint of the marine works, these adverse effects are only predicted to occur at the local level. In the context of the availability of similar habitat across broader geographical scales, the effect of direct loss and physical disturbance to subtidal habitats and communities under the footprint of the marine construction works, for both the replacement and existing outfall scenario, is predicted to be Not Significant.

14.6.22 It is anticipated that there will be no permanent habitat loss in the intertidal zone, meaning that there is no requirement to undertake a formal Biodiversity Assessment using Natural England's 'Defra Metric 2.0' tool[2] to examine biodiversity losses and gains in accordance with National policy drivers. However, given that there will be permanent habitat loss of sandflats within the subtidal zone, a less prescriptive assessment has been undertaken for subtidal habitats using the most relevant and up-to-date guidance.

14.6.23 The total permanent loss of habitat in the subtidal zone, if the outfall head is to be replaced, would equate to an area of 100 m^2. Despite this loss of sandflat habitat, which is homogenous across the Tees Bay, it is considered that the introduction of rock armouring / scour protection (with an expected volume of 250 m^3) provides artificial reef habitat that will be colonised by flora and fauna meaning that overall biodiversity net loss would be offset. There is therefore considered to be no requirement for additional mitigation, enhancement or compensatory measures in relation to the loss of marine biodiversity as a consequence of the Proposed Development.

14.6.24 Whilst noting it does not constitute a requirement, industry best-practice and ecological (marine) enhancement measures would be considered, as appropriate, in the event that a replacement outfall / outfall head is required within the Water Discharge Connection Corridor. Examples of practical measures could include the cutting of grooves in the rock armouring and insertion of pilot holes to help promote colonisation of material.

Fish and Shellfish

14.6.25 Fish and shellfish may be affected by the direct loss and physical disturbance of functional habitats (i.e. those used for spawning or as nursery grounds)

under the footprint of the temporary or permanent marine construction works, with less mobile or benthic life stages (e.g. eggs and larvae) and species (e.g. shellfish) potentially unable to escape and vulnerable to mortality.

14.6.26 Migratory fish species are not considered to have any functional associations with benthic habitats under the footprint of the marine construction works due to their life history strategies and transient presence. The migratory fish species identified are considered to be concentrated in the River Tees where they migrate upstream to spawn in freshwater habitats, and so are unlikely to be close to marine construction activities in Tees Bay. Therefore, potential effects from the direct loss and physical disturbance of habitats are not considered for this receptor group.

14.6.27 The area under the footprint of the marine construction works is not considered to provide particularly important functional habitat for most non-migratory fish and shellfish. The only exception is sandeel (*Ammodytes* spp.) as there is evidence to suggest that this species utilises inshore areas as a nursery ground as outlined in Appendix 14B: Fisheries and Fish Ecology (ES Volume III, Document Ref. 6.4). This species exhibits a degree of site fidelity and is therefore likely to be more vulnerable to habitat disturbance than other fish species.

14.6.28 Nonetheless, the majority of species and life stages known to be present in the area are mobile and would be able to move away from the disturbance. Owing to the widespread prevalence of the same or similar habitats within the area, fish and shellfish are expected to be relatively tolerant of displacement. This includes the ability of sandeels to recolonise nearby suitable sediments during and following completion of the works. Recovery of species populations and habitat function following the temporary loss of subtidal habitat (i.e. from the anchoring, grounding or positioning of marine vessels) would also be expected, although the area this represents is negligible. Overall, the sensitivity of fish and shellfish to direct loss and physical disturbance is considered to be low.

14.6.29 The addition of hard artificial substrate around the outfall head within the Water Discharge Connection Corridor may also provide alternative refuge for fish (e.g. rocky reef dwelling taxa such as Gobiidae, wrasse and juvenile sand smelt) and shellfish (e.g. lobster and crab) as well as provide food resources once benthic communities have become established on these structures.

14.6.30 Overall, although there is potential for some direct loss of functional habitat and physical disturbance to fish and shellfish (excluding migratory fish) within the footprint of the marine construction works, given the localised and temporary nature of the impact, there is unlikely to be any discernible effect to functional habitats or species populations. Thus, the effect of direct loss and physical disturbance to fish and shellfish (excluding migratory fish) under the under the footprint of the marine construction works is predicted to be Not Significant.

Marine Mammals and Designated Sites

14.6.31 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to

marine mammals including harbour seals (which are a feature of the Teesmouth and Cleveland Coast SSSI) is predicted to be Not Significant.

Physical Disturbance to Benthic Habitats and Species from Increased Suspended Sediment Concentrations (i.e. Turbidity) and Deposition

14.6.32 The construction activities listed below, all have the potential to increase suspended sediment concentrations (SSC) (i.e. turbidity) and create a sediment plume (with associated deposition effects) within the marine environment:

- discharge of fine sediment in surface water run-off to the Tees Estuary or Tees Bay as a result of construction activities;
- Preparatory dredging to create a pocket for emplacement of a new outfall head (for either the existing or the replacement outfall scenarios) and disposal of dredged material within the marine environment;
- the mobilisation of sediment at the break-out point where the MBT machine emerges into the subtidal (used during the construction of the Water Discharge Connection);
- the release of drilling muds as the MBT machine emerges into the subtidal;
- the installation of rock armouring / scour protection around the new outfall head for either the existing or the replacement outfall; and
- anchoring, grounding or positioning of work boat(s) and / or barge(s) on the seabed to support the refurbishment works of the existing outfall.

14.6.33 Both increased turbidity and deposition can cause physical disturbance to benthic habitats and species with potential for indirect effects to higher trophic levels. The release and re-deposition of sediment-bound contaminants also has the potential to affect benthic habitats and species through toxicity.

14.6.34 The implementation of the temporary drainage system, outlined in Section 14.5: Development Design and Impact Avoidance, is designed to prevent run-off contaminated with fine particulates from entering surface water drains without treatment. This will avoid or reduce impacts to marine ecological receptors from SSC, deposition and the release of sediment-bound contaminants from surface water run-off during the construction phase. This will be subject to frequent sampling of SSC to ensure compliance with requirements for discharge to the marine environment.

14.6.35 In the event that dredging is required, this would be undertaken in accordance with the conditions of a Marine Licence from the MMO; for dredging and disposal specifically, this includes physical and/or chemical analysis under the MMO's SAM process. Detailed discussions regarding the contents and scope of the draft DML have been undertaken with the MMO; a DML is provided with the Application in the draft DCO (Document Ref. 2.1), inclusive of a draft SAM condition.

14.6.36 It is assumed that any dredged material from the Site shall be either placed alongside the new outfall head (where a dredge pocket will be created for the placement of the head and diffuser) or disposed of locally at a licensed marine disposal site. Given the low predicted volume of dredged material for disposal

and the highly dispersive nature of hydrodynamic conditions within the North Sea, there is unlikely to be any impact to benthic habitats and species as a result of this activity. Regarding the disposal site, alongside regular disposals from PD Ports Teesport dredging operations, detailed dispersion modelling has been undertaken for existing consented infrastructure projects seeking to dispose of material at these sites including York Potash (Royal Haskoning DHV UK Ltd., 2015b). Sediments released rapidly settled to the seabed resulting in a very localised area of deposition and impacts to benthos were predicted to be negligible. The results from this modelling exercise support this prediction.

14.6.37 During the construction of the replacement outfall pipeline the MBT machine will break-out into the subtidal when it is likely that some drilling fluid will be released into the marine environment. The drilling fluid will be a water-based mud (WBM) containing bentonite and barite, fine particulate materials, which serve as a lubricant during boring and drilling activities. Thus, at the break-out point there will be a release of WBM which could result in increased SSC and turbidity, which would remain in suspension for longer than coarser substrates (e.g. sand which typifies the sediment found in Tees Bay) because of the particle size. This has the potential to affect a larger distance. However, as the WBM lubricant is not under any pressure during drilling operations the release is expected to be small and therefore, localised.

14.6.38 Data from comparable infrastructure development, indicates that in general, deposition of WBM greater than 3 mm, where effects to sediment oxygen concentration and the structure of benthic communities have been observed[13], would not be expected beyond 250 m of the MBT break-out point (Bakke *et al.,* 2013). Furthermore, the release of WBM would be a single event when the MBT machine emerges at the break-out point in the subtidal and would, therefore, be temporary and short-term only.

14.6.39 Barite is a naturally occurring material originating in sedimentary rock types, such as limestone; Bentonite is a clay-based material, typically produced from treated volcanic ash. Both materials are held within the PLONAR ('Pose Little or No Risk to the Environment') list which, based on expert judgment by a series of competent national authorities, do not need to be strongly regulated (OSPAR, 2019).

14.6.40 In light of this, the release of suspended sediment and subsequent deposition during MBT is not expected to significantly alter the geomorphology or structure of substrates such that there is likely to be indirect effects to marine ecology.

14.6.41 Sediment chemistry investigations in Tees Bay show very low levels of sediment bound contaminants in this area (Appendix 14D, ES Volume III, Document Ref. 6.4), in contrast to historical contamination evident in the sediments of the Estuary (e.g. see PD Teesport Ltd, 2015). The concentration of heavy metals tested were all below Cefas Action Level 1 and only arsenic at two stations, and naphthalene at one station, were found at concentrations marginally above the Canadian TEL limit (Appendix 14D, ES Volume III, Document Ref. 6.4). For more information on sediment quality results, see

[13] The deposition depth at which effects were observed, was based on experiments undertaken by Trannum *et al.* (2010), where drill cuttings were added to benthic sediment box-core samples.

Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2). Thus, the mobilisation of sediments in Tees Bay, is not considered to pose a contamination risk and any disturbed sediments would disperse and settle out and the potential for impact to marine ecological receptors would be limited.

14.6.42 The overall significance of effects to marine ecological receptors is assessed in the following sections.

Subtidal Habitats and Communities

14.6.43 Epifaunal abundance within the ZoI for turbidity and sediment deposition effects is thought to be low. The subtidal habitats and communities known to be present in the Tees Bay, including at the existing and replacement outfall are characterised by two 'subtidal sands and gravels' biotopes (EUNIS A5.233 and A5.242). These qualify as habitats of principal importance and as Annex I habitat 'sandbanks slightly covered by sea water all the time' but are habitats that exhibit low sensitivity to disturbance and increased suspended sediments (Tilin and Rayment, 2016; Tilin and Garrard, 2019).

14.6.44 The extent of impact due to the dredging around the outfall head location for both the existing and replacement scenarios is considered to be small and temporary. As the sediment at the dredge location is predominantly sand and gravel, suspended particulate material will rapidly resettle to the seabed. Similarly, seabed sediment mobilised as the MBT machine breaks-out in the subtidal will also settle rapidly close to the break-out point.

14.6.45 Increased SSC and turbidity as a result of the release of WBM would, because of the fine particulate matter, likely occur over a larger distance. However, studies show that deposition of WBM greater than 3 mm, where effects to sediment oxygen concentration and the structure of benthic communities have been observed, would not be expected beyond 250 m from the source of drilling and recovery is expected to occur rapidly following disturbance (Bakke *et al.,* 2013). Thus, the area affected would be small and limited to a single event where WBM is released into the marine environment.

14.6.46 Taking into consideration the design mitigation, the resultant nature of impact pathways on sediment habitats and communities from increased turbidity and deposition (i.e. small in extent, temporary and localised) and the low sensitivity of subtidal habitats and species to increased turbidity and smothering, the effect of construction of the Proposed Development is predicted to be Not Significant.

Fish and Shellfish

14.6.47 Mobile species or life stages would be expected to move away from unfavourable conditions and would be capable of returning to an area once adverse conditions had abated. Although demersal life stages are less able to adapt to adverse levels of turbidity and deposition, many are known to be reasonably tolerant of smothering (Kiørbe *et al*., 1981). Overall, the sensitivity of fish and shellfish to increased SSC and deposition is considered to be low.

14.6.48 The area within the predicted ZoI is not considered to provide particularly important functional habitat for most fish and shellfish (with the exception of sandeel which are known to utilise the area as a nursery ground), nor do

migratory fish species utilise these areas for any specific purpose. Any increase in SSC and turbidity will be localised to the Tees Bay and, given the localised and short-term extent of increased turbidity, there is unlikely to be a plume of sediment which could present a barrier to migration.

14.6.49 Sandeel are adapted to live in highly dynamic environments, characterised by mobile sediments and variable turbidity, and so there is considered limited potential for physiological damage (e.g. disruption to feeding or respiratory) or mortality of adult, juvenile or larval sandeel. Although sandeel do exhibit site fidelity, this species is considered adaptable and physiologically capable of relocating to alternative adjacent habitat temporarily and recolonising suitable sediments following completion of the works. Water currents would also be expected to disperse SSC and remove overlying deposited sediments. Thus, the risk of displacement and physiological damage or mortality of demersal species (such as sandeel) and life stages is considered to be low.

14.6.50 Taking into consideration the design mitigation, the resultant nature of impact pathways on fish and shellfish from increased turbidity and deposition (i.e. small in extent, temporary and short-term) and the low sensitivity of fish and shellfish to increased turbidity and smothering, the effect of construction of the Proposed Development is predicted to be Not Significant.

Marine Mammals and Designated Sites

14.6.51 Sediment dispersion modelling, undertaken for existing consented infrastructure projects seeking to dispose of material at the nearby disposal sites including York Potash (Royal HaskoningDHV UK Ltd., 2015b), has been reviewed to inform the assessment. Based on this, construction of the Proposed Development is not predicted to have any direct effect on marine mammals.

14.6.52 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be Not Significant.

Indirect Effects to Marine Ecology from Changes in Marine Water Quality (Excluding Turbidity)

14.6.53 Discharges into the marine environment during the construction of the Proposed Development could come from the deposition of air pollutants, land drainage and marine vessels, accidental spillages of fuel, oils and chemicals, and the release of WBMs (used during the boring of the MBT for the Water Discharge Connection). These discharges have the potential to alter water quality in terms of physico-chemical, biological and chemical parameters with indirect effects to marine ecology.

14.6.54 As demonstrated by the air quality modelling results presented in Chapter 8: Air Quality (ES Volume I, Document Ref. 6.2), the release of air pollutants produced by land-based construction machinery and vehicles during the construction is predicted to have a negligible effect on air quality. As such, there is considered to be no pathway for impacts to water quality and hence marine ecology.

14.6.55 As part of the boring of the MBT for the replacement outfall, there is likely to be a small release of water based mud (WBM) containing bentonite and barite. Both of these lubricants are included on the OSPAR List of Substances Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR, 2019). As such, any release of WBM into the marine environment at the break-out point of the MBT is not considered to result in changes in marine water quality. Therefore, potential indirect effects to marine ecology have not been considered for this activity.

14.6.56 As outlined in Section 14.5: Development Design and Impact Avoidance, several design and good practice mitigation measures are intended to avoid and reduce the risk of pollution entering the marine environment. This includes installation of a temporary drainage system to manage surface water run-off. It is not currently known where the temporary drainage system would discharge to, but it is assumed that this is likely to be via the existing outfall. This design mitigation of the Proposed Development is summarised in paragraphs 14.5.17 and 14.5.18.

14.6.57 All discharges to the marine environment during the construction phase will be compliant with relevant EQS levels and are expected to comply with the relevant Environmental Permitting requirements; under the Environmental permitting regime, routine water quality monitoring is expected. These measures adhere to the environmental management principles detailed in Chapter 5: Construction Programme and Management (ES Volume I, Document Ref. 6.2). On the basis of the current design there is no need for modelling as discharges from the Proposed Development will comply with Environmental Permitting standards.

14.6.58 Other measures, such as the production of a CEMP and SWMP, as well as adherence to the relevant Pollution Prevention Guidelines and the International Regulations for Preventing Collisions at Sea (IMO, 1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78), are also expected to significantly reduce the risk of accidental spillages of fuel, oils and chemicals.

14.6.59 The direct effects to marine water quality have been considered in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2). Including the mitigation outlined above and in Section 14.5: Development Design and Impact Avoidance, this assessment concluded a slight non-significant adverse effect to the Tees Bay waterbody from changes in surface water quality during the construction phase.

14.6.60 Given the highly dynamic nature of the Tees Bay waterbody, any pollutants or contaminants would be rapidly dispersed and diluted. In light of this and the rapid turnover of marine plankton communities, effects to this receptor are predicted to be negligible.

14.6.61 However, considering the design and good practice mitigation outlined above and in Section 14.5: Development Design and Impact Avoidance, any indirect effects to intertidal and subtidal habitats and species from changes in marine water quality would be expected to be highly localised, temporary and short-term.

14.6.62 Mobile receptors such as some fish species and life stages (including migratory species) and marine mammals would also be able to move away from adverse water quality conditions and so effects to these receptors would be limited. However, there remains potential for indirect effects to intertidal and subtidal habitats and species including less mobile life stages of fish (e.g. demersal eggs and larvae).

14.6.63 Considering the nature of the impact, it is unlikely that there would be any discernible effect to the abundance, distribution or functioning of habitats and species populations beyond the local level. Thus, indirect effects to marine ecology receptors from changes in marine water quality (excluding turbidity) during construction of the Proposed Development are predicted to be Not Significant.

Changes in Underwater Soundscape

14.6.64 The following construction activities associated with the Proposed Development will create underwater sound and vibration within the marine environment which has the potential to impact fish and marine mammals:

- drilling of the pin piles for installation of the outfall head;
- the boring of the MBT as part of the replacement outfall;
- dredging of pocket around new outfall head;
- rock placement on the seabed;
- marine vessel movements;
- geophysical surveys; and
- unexploded ordnance (UXO) detonation (if required).

14.6.65 There has been very little research into the impact of underwater sound on marine invertebrates (including shellfish), focussed largely on the impacts of sound for commercially valuable crustaceans. Marine invertebrates are believed to be sensitive to particle motion rather than to sound pressure (Popper and Hawkins, 2018). This is due to the presence of statocysts (tactile hairs or mechano-sensory systems) in many invertebrates, which are thought to be able to detect the particle displacement components of an impinging sound field and not to the pressure component (Popper *et al.,* 2001). For example, it is believed that the detection of particle motion in crustaceans and the prevalence of sound produced by many species may be an important method of communication between individuals (Lovell, 2005; Spiga *et al.,* 2012).

14.6.66 A study of shore crabs (*Carcinus maenas*) exposed to playbacks of sound from ships (for 15 minutes at 148-155 dB_{rms} re. 1µPa) demonstrated higher metabolic rates, indicating higher cardiovascular stress, compared to individuals exposed to ambient sound levels (Wale *et al.,* 2013). Blue mussels (*Mytilus edulis*) were shown to have increased clearance rates (the rate at which filter-feeders sift suspended particles from the water) when exposed to sound from pile driving (158 dB SEL_{ss} re. $1\mu Pa^2 \cdot s$) (Spiga *et al.,* 2016). Increased clearance rates can be a response to higher levels of metabolism and may indicate increased levels of stress to noise.

14.6.67 At present there are no published sensitivity thresholds for this receptor group. Furthermore, whilst there is evidence that some adult crustaceans are affected by exposure to high-level sound sources, such as seismic arrays and impact piling, the observed impact is often minimal, and in some instances, there is no detectable response at all. The current project activities will not result in very high intensity underwater sound. Therefore, the assessment of underwater sound effects has focussed on impacts to fish and marine mammals, receptor groups which are highly sensitive to underwater sound and for which there is recognised to be an important and often significant interaction.

14.6.68 Sound can be either impulsive in nature, such as that created by some high-resolution seabed imaging sources such as multibeam echo-sounding (MBES) and impact piling or continuous in nature such as that from vessel movements, dredging and drilling. For underwater sound impact assessments, the metrics are sound pressure level (SPL) and sound exposure levels (SEL). The SPL is a measure of the amplitude or intensity of a sound and, for impulsive sound sources, is typically measured as a peak or rms (root-mean-square) value[14]. In contrast, the SEL is a time-integrated measurement of the sound energy, which takes account of the level of sound as well as the duration over which the sound is present in the acoustic environment.

Underwater Sound Modelling Approach

14.6.69 To determine whether the construction activities are likely to generate sound propagation which may exceed the thresholds of marine ecological receptors, a simplified geometric spreading model has been used. This approach has been discussed with the MMO and agreed during the pre-application process. The approach takes into account the maximum sound source level (SSL) and the transmission loss (TL) to calculate the received level (RL) of sound at a particular receptor:

$$RL = SSL - TL$$

14.6.70 The SSLs used within the assessment are summarised in Table 14-7. Generally, the source level is calculated by measuring the SPL in the acoustic far-field of the source (typically 100's m or several kms from the sound source), in a specified direction, and propagating the value back to the reference distance of 1 m from the acoustic centre of the source using an appropriate propagation model. This can lead to sound levels in the 'near field' / close proximity to source being under or over-estimated (Farcas *et al*., 2016).

14.6.71 The propagation of underwater sound (i.e. the TL) is modelled using the standard acoustic geometric spreading formula (Xavier, 2002) given below:

$$TL = A \log (r) + B r + C$$

Where:

TL is the transmission loss at a distance r from the source.

A is the wave mode coefficient. For spherical waves A = 20, and cylindrical waves A = 10

[14] Note that there is some inconsistency in the use of underwater sound metrics in the literature. In particular, the route mean squared (rms) metric for Sound Pressure Level is widely recognised as being of relevance to continuous sound sources only but historically it has also been used to describe impulsive sound sources.

B is an attenuation factor that is dependent on water depth and sea bottom conditions.

C is a fixed attenuation due to acoustic screening. In open water this will be 0.

14.6.72 In a free acoustic field without any reflecting boundaries, such as in deep mid-ocean water, the sound will decrease by 20 log (r) (i.e. spherical spreading) as the energy is dispersed over a large area in all directions. In shallow water the bottom and water surface will reflect the sound, causing interferences and the transmission loss will be better described by 10 log (r) (cylindrical spreading). However, transmission loss is also affected by frequency of the sound source. Therefore, given the shallow water depths within the vicinity of the Site (i.e. <200 m) (Illingworth and Rodkin Inc, 2016) and the nature of the sound sources, a wave coefficient of A=15 has been assumed for all construction and geophysical activities and A=10 for UXO (as recommended in Soloway and Dahl (2014). Nevertheless, a geometric spreading approach can only give a rough approximation to actual spreading loss, particularly in a shallow coastal environment where the spreading model cannot account for the manner in which underwater sound interacts with a topographically complex seafloor.

14.6.73 The sound propagation for UXO explosions has been calculated using the following semi-empirical formula originating from the Kirkwood-Bethe propagation theory, presented by Soloway and Dahl (2014).

$$P_{peak} = 52.4 \times 10^{6} \left(\frac{R}{W^{\frac{1}{3}}} \right)^{-1.13}$$

Where:

R is the measurement distance, and W the charge weight in kg Trinitrotoluene (TNT).

14.6.74 The detonation of two TNT equivalent charge weights have been modelled – 100 kg which is based on a “typical” ex-WWII North Sea air-dropped ordnance, and a more conservative charge weight of 55 kg.

Table 14-7: Sound Source Levels Assumed within the Geometric Spreading Model

Construction activity	Sound type	Sound Source Level, dB rms re. 1µPa-m	Wave mode coefficient, A	Reference
Drilling of pin piles	Non impulsive	165 (rms)	15	Washington State Department of Transportation (2007)
Dredging / Micro-bore tunnelling (break-out)	Non impulsive	178 (rms)	15	Greene (1987) in Genesis (2011)
Vessel movements – assumed small (<50 m) and medium (50 – 100 m) vessels as worst-case	Non impulsive	160 – 180 dB (rms)	15	Genesis (2011) Richardson *et al*. (1995) OSPAR Commission (2009)
Swathe or multi-beam echo sounder	Impulsive	232 (rms) 235 (peak)	15	Genesis (2011)
Side scan sonar	Impulsive	220 – 226 (rms) 223 – 229 (peak)	15	Genesis (2011)
Ultra-Short Base Line (USBL)	Impulsive	204 (rms) 207 (peak)	15	Applied Acoustics Engineering Ltd. (nd.)
UXO explosions – assumed 55 kg and 100 kg charge weight as worst-case	Impulsive	289 (peak)	10	Soloway and Dahl (2014)

14.6.75 The principle limitation of using the spreading law model, as undertaken here, is that it does not account for the main mechanism for sound propagation in shallow water (such as in the Tees Bay), the repeated reflection and scattering from the sea surface and seafloor boundaries. These are particularly important in topographically complex coastal and estuarine environments, yet the modelling can only assume a free acoustic field. In addition, transmission losses due to scattering and diffraction are also not included within the model predictions, nor is the effect of the ambient underwater sound environment (i.e. baseline conditions).

14.6.76 Furthermore, propagation loss calculated on the basis of the spreading law model underestimates sound exposure close to the source, which is the region where sound levels are highest (and risk of injury and disturbance is greatest) and overestimates sound levels further from the source, giving the potentially misleading impression that a larger area would be affected (Farcas *et al*., 2016). Geometric spreading propagation modelling also overestimates sound exposure because it assumes both a stationary receptor and a stationary sound source. Whilst the sound source may be derived from a fixed location, some sound sources (e.g. vessel sounds and geophysical surveys) and most marine ecological receptors will be highly mobile. Most individual animals such as fish and marine mammals are unlikely to remain in the same location for

very long and in the presence of obtrusive underwater sound there is a high likelihood that they will move away, reducing the sound energy experienced with distance.

14.6.77 Whilst these limitations are widely recognised it is important to note that geometric spreading propagation modelling is highly precautionary. In the absence of further information of the exact details of the construction methodology, this approach has been used to represent a worst-case; the rationale for the use of this method has been presented to the MMO and in agreed, based on the scale, nature and extent of works and on the basis that it provides a precautionary assessment.

14.6.78 The consideration of UXO disposal operations will be largely hypothetical during the earlier stages of consenting for the Proposed Development. This is because the exact location, nature and disposal requirements of a UXO or UXOs is unknown and cannot be ascertained prior to DCO submission. For this reason, it is expected that the Marine Licence will include conditions to require the detailed consideration of UXO disposal activities, and any required mitigation measures, at the time of a UXO anomaly being discovered. This is a typical approach for UK coastal infrastructure projects and furthermore, detailed discussions regarding the contents and scope of the draft DML (including draft conditions associated with this topic) have been undertaken with the MMO. identified. A DML is provided with the Application in the Draft DCO (Document Ref. 2.1) which includes details of how UXO disposal operations would be considered.

14.6.79 Measures to manage the risk of encountering UXO during the construction phase including during MBT and HDD activities, have been outlined in Chapter 5: Construction Programme and Management (ES Volume I, Document Ref. 6.2).

Fish and Shellfish

14.6.80 Underwater sound can cause a variety of effects to fish. In extreme cases, such as high intensity shock wave effects from UXO detonation, physical injury including rupturing of the swim bladders and subsequent death and effect such as haemorrhaging, embolism and bulging eyes may occur (Halvorsen *et al*., 2012). More commonly, a range of other physiological effects such as physical damage to the auditory system structures (i.e. inner ear / sensory hair cells and otoliths) may occur (Nedwell *et al*., 2006). Temporary threshold shift (TTS) is a common auditory impact representing an elevation in hearing threshold (i.e. a non-permanent reduction in hearing sensitivity). Behavioural effects are also of significant concern, particularly during fish migratory periods when underwater sound may form a barrier to movement.

14.6.81 The impact pathway of sound on fish is, to a large extent, determined by the physiology of fish, particularly the presence or absence of a swim bladder and the potential for the swim bladder to improve the hearing sensitivity and range of hearing (Popper *et al*., 2014). These morphological features have been used to develop categories of fish depending on how they might be affected by sounds and these are used when assessing impacts. Fish have been grouped into the following three categories of hearing sensitivity to underwater sound as described below:

- **High hearing sensitivity fish** – species in which hearing involves a swim bladder or other gas volume (e.g. Atlantic cod, herring and relatives). These species are susceptible to barotrauma and detect sound pressure as well as particle motion.
- **Medium hearing sensitivity fish** – species with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g. Atlantic salmon, sea trout and European eel). These species are susceptible to barotrauma although hearing only involves particle motion, not sound pressure.
- **Low hearing sensitivity fish** – species with no swim bladder or other gas chamber (e.g. dab and other flatfish and elasmobranchs) are less susceptible to barotrauma detecting particle motion rather than sound pressure.

14.6.82 Several fish species with medium to high hearing sensitivity (e.g. Atlantic salmon, cod, herring, European eel and sea trout) known to be present in the River Tees are UK BAP priority species and / or species of principal importance. During the spring, summer and autumn months, there is potential for migratory fish species to pass by the Site.

Fish Sensitivity Thresholds

14.6.83 Popper *et al.* (2014) provide the most up-to-date acoustic sensitivity thresholds for the fish groups identified above and the use of these thresholds is consistent with outputs from pre-application discussions with the MMO and their specialist advisers, Cefas. There are criteria for different sound sources including impulsive sound sources such as seismic guns, impact piling and explosions (e.g. UXO detonation) and continuous sound sources, which includes underwater sound from vessel movements and drilling.

14.6.84 With the exception of explosions, the only impulsive sound source generated by the Proposed Development will be the use of multibeam echo-sounding, side scan sonar and sub-bottom profiling equipment for a geophysical survey proposed for the project. These sound sources are high frequency, ≥ 10 kHz, in nature and beyond the hearing of fish (Popper et al., 2014) and for this reason there are no quantitative thresholds available for fish and no assessment undertaken.

14.6.85 There are however, thresholds for explosions, shown in Table 14-8, which are applicable for UXO detonations, and criteria for non-impulsive (i.e. continuous) sound sources as shown in Table 14-9. For UXO detonation, the Popper *et al*. (2014) threshold for eggs and larvae are for the effect of vibration, rather than sound.

14.6.86 For impulsive sound sources, the injury thresholds are expressed as dual criteria including a single strike peak sound pressure level (SPL) and cumulative sound exposure level (SEL). The impact zone and assessment of effects to fish and other marine species is based on the criteria which generates the largest estimated distance.

14.6.87 Where a quantitative threshold is not available, due to a lack of scientific information, qualitative impact criteria are provided in terms of relative risk (high, moderate, low) given for fish at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F); "near" is considered to be in the tens of metres from the source, "intermediate" in the hundreds of metres, and "far" in the thousands of metres.

Table 14-8: Fish Sensitivity Thresholds for Fish for Explosions (UXO Detonation)

Sensitivity group	Mortality / mortal injury	Recoverable injury	TTS	Behaviour
Low sensitivity fish	229 - 234 dB peak	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Medium sensitivity fish	229 - 234 dB peak	(N) High (I) High (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) High (F) Low
High sensitivity fish	229 - 234 dB peak	(N) High (I) High (F) Low	(N) High (I) High (F) Low	(N) High (I) High (F) Low
Eggs and larvae	>13 mm s −1 peak velocity	(N) High (I) Low (F) Low	((N) High (I) Low (F) Low	(N) High (I) Low (F) Low

Source: Popper et al. (2014)

Table 14-9: Fish Sensitivity Thresholds for Non-Impulsive Sound Sources

Sensitivity group	Mortality / mortal injury	Recoverable injury	Temporary Threshold Shift (TTS)	Behaviour
Low sensitivity fish	(N) Low (I) Low (F) Low	N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low
Medium sensitivity fish	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low
High sensitivity fish	(N) Low (I) Low (F) Low	170 dB SPL_{rms} (unweighted) re. 1µPa, for 48 hours	158 dB SPL_{rms} (unweighted) re. 1µPa, for 12 hours	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low

Source: Popper et al. (2014)

Modelling Results and Assessment for Fish – Explosions (UXO Detonations)

14.6.88 The results of the underwater sound modelling, for the two charge weights, have been compared to the sensitivity thresholds for fish to show the estimated distances (i.e. impact zones) at which the different ecological effects may occur as a result of explosions (Table 14-10). Predicted distances can only be calculated for Mortality and potential mortal injury, as all other sensitivity thresholds are qualitative (Table 14-11). Thus, for recoverable injury, TTS and behavioural responses the assessment has been made using the qualitative criteria provided by Popper *et al.* (2014) and thus impact distances are estimated in broad terms.

14.6.89 For UXO detonations using a TNT equivalent charge weight of 100 kg, the geometric spreading model predicts that mortality of fish may occur up to 473 m from the detonation (Table 14-10). An almost 50% reduction in charge weight would reduce the worst-case impact zone to 388 m. However, sub-lethal effects (i.e. recoverable injury, TTS and behavioural disturbance) could occur at greater distances.

Table 14-10: Fish Impact Zones for UXO Explosions

Receptor	Effect	Threshold level (impulsive sound source)		55 kg charge weight	100 kg charge weight
All fish (irrespective of sensitivity)	Mortality and potential mortal injury	234 1µPa	dB peak (unweighted) re.	233 m	284 m
		229 1µPa	dB peak (unweighted) re.	388 m	473 m

14.6.90 UXO detonations, if required, would be expected to occur in the Tees Bay. Standard JNCC mitigation measures for using explosives shall be applied in the event that a UXO detonation is required during the construction phase (JNCC, 2010a). This shall include the use of 'soft-start' which would involve detonation of a sequence of smaller chargers to deter fish beyond the potential range of injury prior to the UXO detonation. Whilst this would mean fish would be displaced from the area, this effect would be temporary with fish able to return to the area following completion of the works.

14.6.91 Considering the good practice and design mitigation proposed, the potential for lethal effects to fish is considered to be low. Given the short-term and infrequent nature of UXO detonations, effects to fish would be localised and temporary. As such, there is unlikely to be any discernible effect on species populations either via changes in the local distribution, abundance or conservation status of species. Thus, effects to fish and shellfish from UXO detonation during the construction phase are predicted to be Not Significant.

Modelling Results and Assessment for Fish – Non-Impulsive Sound Sources

14.6.92 Based on the sensitivity thresholds outlined in Table 14-9 the potential for mortality or mortal injury, in medium and low sensitivity fish, is considered to

be low even in the near-field (i.e. tens of metres from the sound source). However, there is a moderate risk of behavioural disturbance within the near- and intermediate-field (i.e. hundreds of metres from the sound source).

14.6.93 For high hearing sensitivity fish species, the predicted impact zones for non-impulsive sound sources, including drilling of pin piles, dredging and vessel movements, based on the sensitivity thresholds in Table 14-9 are shown below in Table 14-1. Note that the predictions have only been provided where a quantitative sound threshold is available.

Table 14-11: Fish (High Hearing Sensitivity species only) Impact Zones for Non-Impulsive Sound Sources

Construction activity	High sensitivity fish	
	Recoverable injury 170 dB SPL_{rms} (unweighted) re. 1µPa, for 48 hours	TTS 158 dB SPL_{rms} (unweighted) re. 1µPa, for 12 hours
Drilling of pin piles	<10 m	32 m
Dredging / Micro-bore tunnelling (MBT) break-out	< 10 m	74 m
Marine vessel movements	<10 m	100 m

14.6.94 The results of the geometric spreading model show that for all construction activities which generate a non-impulsive (i.e. continuous) sound source, recoverable injury of highly sensitive fish species is only predicted to occur if individuals were to remain within 10 m from the sound source for a period of 48 hours. The impact zone for TTS varies depending on the activity being undertaken and ranges from 32 m to 100 m, but only where individual fish remain within the impact zones for a period of 12 hours. The qualitative thresholds indicate a moderate risk of behavioural responses at near and intermediate distances from the source.

14.6.95 Both the drilling of pin piles and dredging may need to be undertaken in the Tees Bay, approximately 1 km to the east of from the Tees Mouth (for the existing outfall) with the replacement outfall being a further 2 km east (i.e. a total of approximately 3 km from the Tees Mouth). Therefore, there is not considered to be the potential for these activities to result in a temporary acoustic barrier in the River Tees. It is also likely that South Gare Breakwater may act as an acoustic shield to underwater sound which propagates from these construction activities. As such, migratory fish movements in the River Tees are not expected to be impeded.

14.6.96 With the exception of MBT, all construction activities will be undertaken within the working hours outlined in paragraphs 14.5.12. The MBT may have to operate continuously once started and thus the underwater sound generated at the break-out point could be outside general working hours. However, sound will only be generated at break-out and probably only last a very short time. In addition, there will be a gradual increase in sound level as the MBT machine approaches the seabed, acting as a natural soft-start approach, allowing any nearby fish to move away. None of the other construction activities outlined in Table 14-11 are expected to occur for longer than 12 hours

and in many cases are unlikely to occur continuously for more than a few hours.

14.6.97 The fish with the highest hearing sensitivity are members of the herring family (Clupidea) and are generally pelagic species that are highly mobile and wide-ranging. Thus, for all construction activities it is unlikely that these individuals will remain within the impact zone. Thus, no injurious impacts in fish, from any continuous sound sources are anticipated.

14.6.98 Overall, behavioural disturbance to fish from continuous sound sources would be localised, short-term and intermittent. A degree of habituation would also be expected, particularly given that the Tees Bay is close to the Tees Mouth which is already characterised by a high level of marine traffic transiting to and from the port facilities within the Tees Estuary. More widely, there are several other sources of anthropogenic sound (such as that related to shoreside industrial activity within the Teesport area).

14.6.99 Thus, effects to fish and shellfish from construction activities which generate a non-impulsive (i.e. continuous) sound source are predicted to be Not Significant.

Marine Mammals and Designated Sites

14.6.100 Sound from anthropogenic activities can negatively impact marine mammals as it influences their ability to echolocate, communicate and some sound sources can cause physical harm including impairment of auditory apparatus. Sound can also cause certain cetacean species to change their behaviour and can result in increased alertness, modification of vocalisations, interruption or cessation of feeding or social interactions, alteration of movement or diving behaviour, and temporary or permanent habitat abandonment. In some circumstances, sound from explosions or some military type sonar have been associated with animal responses such as panic, flight, stampede, or disorientation which could lead to stranding, which could sometimes result in indirect injury or death.

14.6.101 Cetaceans produce and receive sound over a great range of frequencies for use in communication, orientation, predator avoidance and foraging (Tyack, 1998). As sound production in marine mammals is integral to a range of important behaviours, any interference with these communicative functions has the potential for adverse effects.

14.6.102 Seals (and other pinnipeds) also produce a diversity of sounds, though generally over a lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz) than cetaceans. Their sounds are used primarily for social and reproductive interaction, both in water and air (Southall *et al*., 2007).

14.6.103 To reflect the different hearing sensitivities of marine mammal species, marine mammals have been classified into functional hearing groups as discussed below (Southall *et al*., 2007; NMFS, 2018, Southall et al 2019)[15]. There is the potential for species in each of the following categories to be present in the vicinity of the Site:

- **Low frequency cetaceans** - baleen whales including the minke whale;
- **Mid frequency cetaceans** - the toothed whales and dolphins including the bottlenose dolphin;
- **High frequency cetaceans** – including harbour porpoise; and
- **Pinnipeds (phocids)** – earless or 'true' seals including harbour and grey seal.

14.6.104 Anthropogenic sound may have a diverse range of effects on marine receptors, from injury to minor behavioural responses. The impact pathways on marine mammals are generally split into the following levels:

- **Effects on hearing** - a consequence of damage to the inner ear of marine mammals, the organ system most directly sensitive to sound exposure and, thus, the most susceptible to sound-derived damage (Southall *et al*., 2007). Hearing loss or a shift in hearing thresholds can be permanent or temporary:
  - **Permanent Threshold Shift (PTS)** - is a permanent elevation in hearing threshold (i.e., an unrecoverable reduction in hearing sensitivity). PTS can occur from a variety of causes, but it is most often the result of intense and / or repeated noise exposures; and
  - **Temporary Threshold Shift (TTS**) - is a recoverable elevation in hearing threshold (i.e., a non-permanent reduction in hearing sensitivity) most commonly resulting from long-term noise exposure not high enough to cause PTS.
- **Behavioural responses** – are highly variable and context-specific ranging from increased alertness, altering vocal behaviour, interruption to feeding or social interaction, alteration of movement or diving behaviour, temporary or permanent habitat abandonment. In some circumstances, sound from explosions or military sonar, have been associated with animal responses such as panic, flight, stampede, or stranding, sometimes resulting in indirect injury or death could occur. Minor or temporary behavioural responses are often simply evidence that an animal has heard a sound;
- **Masking** – anthropogenic underwater sound may partially or entirely reduce the audibility of signals of interest such as those used for communication and prey detection; and
- **Detection** – the limit of hearing. Marine mammals generally have high sensitivity to sound pressure (low detection thresholds) and can hear across a broad range of bandwidths.

[15] Note that Southall *et al*. 2019 uses slightly modified categorisation of hearing groups to NMFS 2018 and Southall *et al*., 2007 renaming Mid Frequency to High Frequency, and High Frequency to Very High Frequency (the NMFS notation is used here)

Marine Mammal Sensitivity Thresholds

14.6.105 There is no evidence in the literature to suggest physical injury has occurred directly as a result of sound from impulsive sound sources but other injurious auditory impacts, such as PTS and TTS, as well as behavioural responses, are possible. The level of auditory impact will depend on the SSL generated, the sound propagation characteristics of the area, duration of the sound generating construction activities and the distance of the marine mammal receptor to the sound source. Behavioural responses are often more variable and context specific.

14.6.106 Table 14-12 and Table 14-13 present the sensitivity threshold criteria for marine mammal groups, defined on the basis of their hearing sensitivity, to impulsive and non-impulsive sound sources, respectively. The thresholds cover the onset of TTS and PTS based on guidance from the National Marine Fisheries Service (NMFS) (2018).

Table 14-12: Marine Mammal Sensitivity Thresholds for Impulsive Sound Sources

Marine mammal hearing group	PTS		TTS	
	SPL*	SEL*	SPL*	SEL*
Low frequency cetaceans	219	183	213	168
Medium frequency cetaceans	230	185	224	170
High frequency cetaceans	202	155	196	140
Phocid Pinnipeds	218	185	212	170

*Units as follows: SPL dBpeak (unweighted) re. 1µPa and SEL dB SELcum (M-weighted) re. 1µPa²s
Source: NMFS (2018)

Table 14-13: Marine Mammal Sensitivity Thresholds for Non-Impulsive Sound Sources

Marine mammal hearing group	PTS (multiple pulses)	TTS (multiple pulses)
	SEL*	SEL*
Low frequency cetaceans	199	179
Medium frequency cetaceans	198	178
High frequency cetaceans	173	153
Phocid Pinnipeds	201	181

*Units as follows: SPL dBpeak (unweighted) re. 1µPa and SEL dB SELcum (M-weighted) re. 1µPa²s
Source: NMFS (2018))

Modelling Results and Assessment for Marine Mammals – Impulsive Sound Sources

14.6.107 The results of the simplified underwater sound modelling have been compared to the sensitivity thresholds for marine mammals to calculate the estimated distances (i.e. impact zones) at which received sound levels decrease to below the threshold values associated with the different ecological effects for impulsive sound sources (Table 14-14 and Table 14-15). Distances

to sound exposure level (SEL) threshold values have been determined for a 1 hour and a 24-hour exposure duration and have been weighted for marine mammal hearing groups, as have the thresholds. These potential impact distances are based on an assumption that both the sound source and the receptor are stationary. Generally, it is predicted that most receptors, particularly those that are mobile, will minimize the amount of time they remain in the closest ranges to a sound source (NMFS, 2018). Exposures at the closest point to the sound source contribute most to the accumulated levels and so potential impact distances using SEL values are therefore highly precautionary.

14.6.108 Based on the expected behaviour of marine mammals, namely that they will move away from anthropogenic sound sources, the 1-hour exposure is considered to be precautionary. Nevertheless, the determination of potential distances for both a 1-hour and a 24-hour exposure provides a range of potential impact zones for consideration.

14.6.109 The results of the simplified underwater sound modelling predicts relatively small impact distances related to higher frequency sound sources (such as those associated with high resolution geophysical surveys) although for high frequency cetaceans, the potential impact zone is estimated to extend up to between 5.7 and 8.6 km from the sound source for TTS and 3 to 5.5 km for PTS (Table 14-14).

14.6.110 For impulsive sound, Southall *et al*. (2007) suggests the onset of significant behavioural disturbance occurs at the lowest level of sound exposure that has a measurable transient impact on hearing, which is TTS. Thus, whilst the TTS threshold is not considered to be a behavioural impact *per se*, this auditory impact can be used as a proxy behavioural threshold in the absence of more appropriate measures. However, it should be noted that behavioural responses are extremely variable and context specific and therefore using a single threshold value is highly limited and conservative. The results are therefore used to help inform the overall assessment of behavioural response rather than being adopted as a definitive indicator of an effect occurring based on the sound level alone.

Table 14-14: Marine Mammal Impact Zones for Impulsive Sound Sources – Geophysical Survey Elements

Marine mammal hearing group	Sound level metric	Swathe or multi-beam echo sounder		Side scan sonar		USBL	
		PTS	TTS	PTS	TTS	PTS	TTS
Low frequency cetaceans	SPL	<10 m	<10 m	<10 m	<10 m	<10 m	<10 m
	SEL (1-hr exposure)	240 m	620 m	70 m	270 m	90 m	650 m
	SEL (24-hr exposure)	600 m	1070 m	240 m	550 m	550 m	2.2 km
Medium frequency cetaceans	SPL	<10 m	<10 m	<10 m	<10 m	<10 m	<10 m
	SEL (1-hr exposure	750 m	1.3 km	410 m	780	180 m	1.0 km

Marine mammal hearing group	Sound level metric	Swathe or multi-beam echo sounder		Side scan sonar		USBL	
		PTS	TTS	PTS	TTS	PTS	TTS
	SEL (24-hr exposure)	1.2 km	1.8 km	750 m	1.1 km	900 m	2.9 km
High frequency cetaceans	SPL	<10 m	20 m	<10 m	<10 m	<10 m	<10 m
	SEL (1-hr exposure	1.9 km	2.5 km	1.2 km	1.6 km	3.0 km	5.7 km
	SEL (24-hr exposure)	2.4 km	3.0 km	1.6 km	2.0 km	5.5 km	8.6 km
Phocid Pinnipeds	SPL	<10 m	<10 m	<10 m	<10 m	<10 m	<10 m
	SEL (1-hr exposure	370 m	800 m	130 m	380 m	120 m	800 m
	SEL (24-hr exposure)	760 m	1.3 km	350 m	700 m	700 m	2.5 km

The distances at which SELcum threshold criteria for marine mammals are met have included consideration of marine mammal auditory weighting functions ('M-weighting') the broadband weighting factor adjustments as set out in Appendix D of NMFS (2018).

14.6.111 Baseline information suggests that harbour porpoise can be expected to occur from time to time within the Tees Bay but are unlikely to venture into the Estuary. Other cetaceans, including bottlenose and white-beaked dolphin and minke whale may be present further offshore on occasion but only in low numbers (see Appendix 14C: Marine Mammal Ecology Baseline, ES Volume III, Document Ref. 6.4). Given the presence of a seal colony at Seal Sands, harbour and grey seals would be expected to occur frequently within the impact zone if the geophysical survey takes place within the Tees Estuary. On this basis, some permanent or temporary injury to the hearing of both pinnipeds and cetaceans could occur and, assuming that the TTS threshold is indicative of a behavioural response, significant behavioural disturbance is also likely to occur.

14.6.112 As outlined in Section 14.5: Development Design and Impact Avoidance, the standard JNCC Guidelines for geophysical surveys (JNCC, 2017) shall be adopted for the Proposed Development as good practice and design mitigation. This would include measures such as a marine mammal observation zone for visual monitoring, passive acoustic monitoring and a soft-start approach which would increase sound levels gradually, allowing any marine mammals, including seals, in the area opportunity to move away.

14.6.113 These measures are mainly aimed at reducing the risk of permanent injury to hearing but can also minimise potential for temporary auditory injury (TTS) and severe behavioural impacts, particularly panic type reactions. They are most effective for the near-field effects, which are greater and possibly underestimated by the geometric spreading modelling (see paragraph 14.6.76 for further information). Far-field effects (e.g. behavioural disturbance), whilst harder to mitigate, are considered to be overestimated by the modelling approach. These results should therefore be interpreted cautiously.

14.6.114 There remains a risk that marine mammals could become displaced during any geophysical surveys as a result of underwater sound. However, geophysical survey works within the Proposed Development boundary would be expected to be short-term, taking approximately 10 days per campaign and during this time, behavioural effects would be intermittent and short-term. Animals can return to the area once the survey has been completed.

14.6.115 Based on the information and mitigation outlined above, the risk of physiological impact to cetaceans is considered to be very low. Given the temporal nature of underwater sound impacts geophysical surveys (i.e. short-term and intermittent) and the resilience of cetaceans to temporary displacement, this construction activity is not predicted to affect the abundance and distribution of harbour porpoise within the wider North Sea, nor is it predicted to have any effect on the conservation status of the Southern North Sea SAC population. Thus, effects to this species and other less sensitive cetaceans from underwater sound generated by geophysical surveys during the construction phase are predicted to be Not Significant.

14.6.116 Given the short-term and intermittent nature of geophysical surveys, temporary displacement of pinnipeds (harbour and grey seal) is not predicted to affect the abundance and distribution of species within the Seal Sands area or within the wider North East Seal Management Unit (i.e. at the regional scale). Thus, effects to pinnipeds and the Teesmouth and Cleveland Coast SSSI (with respect to harbour seal) from underwater sound generated from geophysical surveys during the construction phase are predicted to be Not Significant.

14.6.117 Should detonation of UXOs be necessary, comparing sound levels using the geometric spreading model predicts that TTS (and significant behavioural disturbance) in cetaceans and pinnipeds could occur up to >10 km and 2.7 km away from the sound source, respectively, depending on species sensitivities and the TNT equivalent charge weight used (Table 14-15). For PTS, the worst-case impact zone for cetaceans and pinnipeds is 7.4 km and 1.5 km, respectively. This assessment has been made using the sensitivity thresholds for impulsive sound outlined in Table 14-12.

Table 14-15: Marine Mammal Impact Zones* For Explosions (UXO Detonation)

Marine mammal hearing group	55 kg charge weight		100 kg charge weight	
	PTS	TTS	PTS	TTS
Low frequency cetaceans	1.1 km	2.0 km	1.3 km	2.4 km
Medium frequency cetaceans	350 m	645 m	427 m	787 m
High frequency cetaceans	6.1 km	>10 km	7.4 km	>10 km
Pinnipeds	1.2 km	2.2 km	1.5 km	2.7 km

* Potential impact zones determined on the basis of SPL to reflect only 1 pulse per explosion

14.6.118 The standard JNCC Guidelines for explosions (JNCC, 2010) shall be adopted for the Proposed Development as good practice mitigation. Crucially, this shall include the use of ‘soft-start’ or acoustic deterrent devices to reduce the risk of physiological impacts (i.e. TTS and PTS) and severe behavioural impacts although displacement would occur over potentially considerable

distances. It is anticipated that this, and a range of other potential mitigation, would be secured via condition of the draft DML. Detailed discussions regarding the contents and scope of the draft DML (including draft conditions associated with this topic) have been undertaken with the MMO. A DML is provided with the Application in the draft DCO (Document Ref. 2.1) which includes details of how UXO disposal operations would be considered.

14.6.119 The requirement for UXO detonation remains uncertain although given the small predicted extent of the marine construction works associated with the Proposed Development, the overall number is likely to be low. As such, the temporal nature of impact to marine mammals would be infrequent and extremely short-term with individuals capable of returning to the area following completion of the works.

14.6.120 On this basis, effects to cetaceans including harbour porpoise which is a qualifying feature of the Southern North Sea SAC located approximately 102 km away from the Site from underwater sound generated by UXO detonations during the construction phase are predicted to be Not Significant.

14.6.121 Considering the potential proximity of UXO detonations to the seal haul-out site at Seal Sands, effects to pinnipeds including harbour seal which is a qualifying feature of the Teesmouth and Cleveland Coast SSSI, from underwater sound generated by UXO detonations, within the Tees Estuary, during the construction phase are predicted to be Significant. However, should UXO detonation only be required in Tees Bay or further offshore, with the adoption of the JNCC standard mitigation measures (JNCC, 2010, the effect of UXO on seals is predicted to be Not Significant.

14.6.122 To reduce the likelihood of impact it is proposed as additional mitigation that UXO detonations within the Tees Estuary should be carried out outside of the sensitive breeding and moulting season for harbour seals (June to early September). However, abatement measures, such as implementation of acoustic barrier technologies, deflagration and the use of acoustic deterrent devices, shall also be investigated depending on the nature of the UXO identified and the location and incorporated into the Proposed Development where practicable.

14.6.123 With the adoption of a temporal restriction on UXO detonations in the Tees Estuary, and the adoption of standard JNCC mitigation Guidelines for explosions, JNCC, 2010) elsewhere, the effects to pinnipeds from underwater sound generated by UXO detonations during the construction phase are predicted to be Not Significant.

Modelling Results and Assessment for Marine Mammals – Non-Impulsive (I.E Continuous) Sound Sources

14.6.124 Table 14-16 presents the estimated distances (i.e. impact zones) at which PTS and TTS may occur in marine mammals as a result of cumulative exposure to non-impulsive (i.e. continuous) sound sources for a period of 1 and 24 hours.

14.6.125 In practice however, marine construction activities which generate non-impulsive sound sources are not expected to operate continuously and any dredging vessels will not be stationary, though they may be restricted to a local area. For example, the drilling of pin piles is an intermittent activity, which often

starts and stops at regular intervals for technical and logistical reasons (i.e. checking position tolerances during installation etc) such that there are regular breaks in sound generation. Thus, the calculation of the potential impact distances for non-impulsive sound sources for a 1-hour and a 24-hour period provides an impact zone range for consideration.

14.6.126 In addition, the calculations are based on an assumption that both the sound source and the receptor are stationary. In most cases mobile marine receptors, such as marine mammals, are unlikely to remain in a single location for long and as an animal moves away from the sound source the sound pressure level, and hence the sound exposure, decreases. Furthermore, the geophysical vessel will also be moving and so estimated distances, particularly for the far-field, will be significantly overestimated. Thus, for auditory impacts (PTS and TTS) the impact distance estimated by the shorter sound exposure time, of 1-hour, is considered to be most appropriate.

14.6.127 For drilling of pin piles, PTS in all marine mammals is predicted to occur within 69 m from the sound source. Larger PTS impact zones are predicted for dredging and general marine vessel movements, particularly for high frequency cetaceans (e.g. harbour porpoise). PTS is predicted to occur at distances up to 688 m for high frequency cetaceans, whilst for all other marine mammal hearing groups, the impact zone is predicted to be no more than 15 m.

14.6.128 The estimated impact distance for TTS is within 319 m for low and medium frequency cetaceans and pinnipeds, whereas for high frequency cetaceans TTS is predicted to occur at distances up to and beyond 10 km. Whilst the far-field impacts are expected to be over-estimated by the use of geometric sound propagation calculations, the results do show there is a risk of TTS occurring for high frequency marine mammals that remain in the vicinity of drilling, dredging and marine vessels for longer than an hour.

Table 14-16: Marine Mammal Impact Zones* for Non-Impulsive Sound Sources (1-hour and 24-hour Exposure)

Marine mammal hearing group	Exposure time (hours)	Drilling of pin piles		Dredging/MBT break-out		Marine vessel movements	
		PTS	TTS	PTS	TTS	PTS	TTS
Low frequency cetaceans	1	< 10 m	27 m	10 m	201 m	13 m	274 m
	24	11 m	228 m	78 m	1676 m	106 m	2279 m
Medium frequency cetaceans	1	< 10 m	32 m	11 m	235 m	15 m	319 m
	24	12 m	266 m	91 m	1954 m	123 m	2657 m
High frequency cetaceans	1	69 m	1482 m	506 m	>10 km	688 m	>10 km
	24	572 m	> 10 km	4211 m	>10 km	5724 m	>10 km
Pinnipeds	1	< 10 m	20 m	< 10 m	148 m	< 10 m	201 m
	24	< 10 m	168 m	57 m	1233 m	78 m	1676 m

* The distances at which SELcum threshold criteria for marine mammals are met have included consideration of marine mammal auditory weighting functions ('M-weighting') the broadband weighting factor adjustments as set out in Appendix D of NMFS (2018).

14.6.129 Marine mammals are highly mobile, and whilst many dolphin species are known to bow-ride fast moving vessels, this is normally for short-periods only (i.e. <1-hour). Most cetaceans would be expected to move away from sources of underwater noise disturbance and so the potential for PTS is considered to be low. Nonetheless, there remains significant potential for individuals, probably within intermediate distances from the sound source (as indicated by the relevant modelling distances) to be subject to TTS, with the magnitude of effects diminishing with distance.

14.6.130 For behavioural disturbance, a Sound Pressure Level (rms) threshold of 120 dB re 1µPa for continuous sounds is used to determine impact zones for the assessment of impacts for the issue of Incidental Take Authorisations for 'Level B Harassment' under the US Marine Mammal Protection Act (MMPA) (NOAA, 2021[16]). The predicted impact distance predicted by this threshold, using geometric spreading calculations, is >10 km for vessel movements, 7356 m for dredging and 1000 m for pin pile drilling. This indicates that behavioural responses have the potential to occur some distance from the Proposed Development for some activities.

14.6.131 Although modelling of the propagation of underwater sound was not undertaken for the boring of the MBT (as part of the activities involved with the potential construction of the replacement outfall), it is anticipated that any effects will be limited to when the MBT machine emerges in the subtidal which will be for a short and limited period of time. Furthermore, as the MBT machine gets closer to the seabed, there will be a gradual increase in sound levels, allowing any marine mammal individuals to move away from the area of impact. As a result, the potential for PTS and TTS due to the boring of the MBT is predicted to be low.

14.6.132 For all construction activities for which there will be non-impulsive sound sources, TTS and behavioural disturbance effects are predicted to be temporary, short-term and intermittent. A degree of habituation would also be expected, particularly given the surrounding area (and particularly the Tees approach channel) is already characterised by a reasonably high level of marine traffic transiting to and from the port facilities within the Tees Estuary. In light of this, using non-impact piling methods (only drilling of pin piles required), there is considered to be limited potential for detectable changes in the abundance, distribution and conservation status of marine mammals. Thus, effects to marine mammals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI and harbour porpoise – Southern North Sea SAC), from underwater sound generated by non-impulsive sound sources during the construction phase are predicted to be Not Significant.

[16] https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west

Changes in the Airborne Soundscape During Construction

14.6.133 Marine and land-based construction activities associated with the Proposed Development will create airborne sound which has the potential to disturb pinnipeds (i.e. seals) that have surfaced or have hauled out. Disturbance effects might include cessation of feeding, resting, travelling and / or socialising, with possible long-term effects of repeated disturbance resulting in permanent displacement and / or a decline in fitness and productivity (e.g. moulting or breeding success).

14.6.134 There is a haul-out site for grey seals and breeding harbour seals at Seal Sands which is located approximately 0.6 km from the proposed Site boundary (the closest area being the CO_2 gathering network / Natural Gas Connection). Further haul-out sites are located at Greatham Creek and Bailey Bridge approximately 1.6 km and 0.9 km away from the proposed Site boundary, respectively. Seal Sands supports the greatest number of seals followed by Greatham and Bailey Bridge. On Seal Sands, the majority of harbour seals and grey seals are known to haul out at Sites A and D, respectively (Diagram 14-1).

Diagram 14-1: Location of Haul Out Sites on Seal Sands (Source: INCA, 2019)

14.6.135 As outlined in Chapter 11: Noise and Vibration (ES Volume I, Document Ref. 6.2), ambient sound measurements were made at the Seal Sands industrial area in December 2019 during the daytime. The L_{Aeq} measured 68 dB whilst the representative $L_{A90,15min}$ and highest $L_{Amax,15\ min}$ measured 56 dB and 83 dB, respectively. The major source of sound at this location was industry but there was also a significant contribution from the unnamed road through the Seal Sands industrial estate. The monitoring site (E4 – see Figure 11-1 in ES Volume II, Document Ref. 6.3) is located approximately 1.2 km away from where seals are known to haul out and is therefore expected to overestimate baseline conditions within the immediate vicinity of hauled out individuals.

14.6.136 Indicative predictions of construction sound levels have been made to determine the impacts of construction activities on sensitive human and ecological receptors. The free-field (A-weighted) sound level at a particular receptor for each construction activity has been predicted assuming a 12-hour working day. Further details on the construction sound prediction methodology can be found in Chapter 11: Noise and Vibration (ES Volume I, Document Ref. 6.2).

14.6.137 During the construction phase, the closest activities to Seal Sands, are the works associated with the CO_2 Gathering Network and the Natural Gas Connection. The activity which is predicted to generate the highest sound impacts for seals hauled out at Seal Sands is the CO_2 pipeline construction, including pipe stringing and welding. This activity has been considered as a worst-case for the construction phase and may impact seals either surfaced or hauled out throughout the year. Based on the current indicative construction programme, works as part of the CO_2 Gathering Network and the Natural Gas Connection will last for 1-year.

14.6.138 The activity of pipe stringing and welding as part of the CO_2 pipeline construction is located ~0.75 km away from the CO_2 pipeline construction. The estimated sound level at the nearest part of the Seal Sands mudflat to the sound source (i.e. l) of 46 $L_{Aeq,\ 12h}$.

14.6.139 The sound exposure level weighted thresholds for the onset of TTS and PTS in phocids (harbour and grey seals) are 134 and 154 dB re (20 µPa) in air (Southall *et al*., 2019). These sound exposure level thresholds use a weighting specific to the phocid seal group (Southall *et al*., 2019) which differs slightly from the A-weighting that has been applied within the model and is typically used for human receptors. These weightings reflect variations in peak sensitivity of the two receptor groups, which occurs around 10 kHz for marine species and around 1 – 4 kHz for humans (i.e. marine species are more sensitive to high frequency sound than humans).

14.6.140 Construction activities would be expected to be dominated by low- or mid-frequency sound. Furthermore, there is also likely to be less propagation of high frequency sound (compared to mid- or low-frequency sound) due to ground absorption and dispersion. Thus, in the absence of high frequency sound it is considered reasonable to assume that the predicted human A-weighted sound pressure level (L_{Aeq}) is equivalent (and a likely worst-case) to phocid-weighted sound pressure level. However, to permit a comparison

between the L_{Aeq} value and the TTS and PTS thresholds for seals in air provided by Popper et al., 2014 (which are expressed in different units) (Table 14-17), the predicted L_{Aeq} levels have been reported as 12-hour unweighted sound pressure levels and then converted to an unweighted SEL. The predicted and threshold values can then be compared for determination of likely impact for phocid seals.

14.6.141 The predicted unweighted 12-hour sound exposure level, at the nearest part of the Seal Sands mudflat to the CO_2 Export Pipeline construction, is predicted to be 97 dB which is considerably less than the 134 dB and 154 dB onset threshold for TTS and PTS given by Southall *et al*. (2019).

14.6.142 Even when summing the measured ambient sound levels with the predicted levels at Seal Sands due to CO_2 Export Pipeline construction, such as pipe stringing and welding (see paragraph 14.6.135), sound levels are predicted to be below TTS and PTS thresholds. Thus, it is considered unlikely that seals hauled out at Seal Sands would be vulnerable to temporary auditory damage due to changes in the airborne soundscape during the CO_2 Export Pipeline construction. Using the TTS threshold as a proxy behavioural threshold, the risk of behavioural disturbance is also considered to be negligible.

Table 14-17 Predicted Airborne Sound Levels at Seal Sands from pipe stringing and welding as part of the CO_2 pipeline construction

Location	Distance to CO_2 pipeline construction activity (m)	Predicted free-field sound level for pipe stringing and welding (unweighted) $L_{eq,12h}$	Sound exposure level (unweighted)
Nearest part of the mudflat	750	51	97

14.6.143 In practice, the pipe stringing and welding activity would not be expected to operate continuously during the working day and is unlikely to be undertaken across the entire year of construction (as per the current indicative construction programme for the CO_2 Gathering Network and the Natural Gas Connection). Seals are also highly mobile and so individuals would be expected to move away from airborne sound disturbance if hauled-out too close, although a degree of habituation would also be expected given the industrialised nature of the Estuary.

14.6.144 In light of this, there is considered to be limited potential for detectable changes in the behaviour, abundance, distribution and conservation status of harbour and grey seals as a consequence of changes to the airborne soundscape during construction. Thus, effects to seals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI) are predicted to be Not Significant.

Changes in Visual Stimuli (Including Artificial Light)

14.6.145 Land and marine-based construction activities could result in changes in visual stimuli (including artificial light) leading to avoidance behaviour in marine organisms which could affect breeding or foraging activities, with potential for wider implications for populations.

14.6.146 It can often be very difficult to separate out the relative contribution of different stimuli causing disturbance to marine organisms. However, for larger taxa which occur in shallow or surface waters (e.g. fish and marine mammals) and those that migrate onto land (e.g. seals hauled out), changes in visual cues (particularly light) are known to strongly influence behaviour.

14.6.147 As design mitigation, it is proposed that construction and operational lighting will be arranged so that glare and light spill into the marine environment is minimised. This measure will apply to land-based lighting as well as lighting on marine vessels operating in the adjacent coastal environment. An Indicative Lighting Strategy (Document Ref. 5.11) has been prepared to accompany the Application.

Fish and Shellfish

14.6.148 Fish species are photoreceptive, with key activity rhythms and behavioural patterns (e.g. feeding) stimulated by light. Daytime feeders are generally attracted to light whilst nocturnal species (e.g. carnivores) exhibit strong avoidance of light (Marchesan *et al*., 2005). Shellfish typically exhibit higher activity levels in the hours of darkness (Robson *et al*., 2010).

14.6.149 Given the design mitigation outlined above, any changes in visual stimuli to fish and shellfish would be highly localised to the construction works or Site and therefore the spatial extent of any disturbance would be small. The majority of lighting, plant and personnel would also be mobile and so any effect would be temporary, short-term and intermittent.

14.6.150 It is likely that other sources of disturbance (e.g. changes in the underwater soundscape) would deter fish from the vicinity of marine construction works thereby reducing the likelihood of visual disturbance. Any avoidance or attraction of fish to the construction activities within or adjacent to the marine environment is unlikely to affect the integrity of populations given the availability of alternative habitats elsewhere in Tees Estuary and Tees Bay. Thus, effects to fish and shellfish from changes in visual stimuli during the construction phase are predicted to be Not Significant.

Marine Mammals and Designated Sites

14.6.151 Seals which have surfaced or hauled-out could be affected by changes to visual stimuli causing individuals to stop resting, feeding, travelling and / or socialising, with possible long-term effects of repeated disturbance resulting in permanent displacement and / or a decline in fitness and productivity.

14.6.152 In general, shipping traffic more than 1,500 m away from a haul-out site is not thought to evoke any reaction. However, between 900 m and 1,500 m, grey seals could be expected to detect the presence of vessels; and at closer than 900 m, a flight reaction may occur (Scottish Executive, 2007). Studies of harbour seals have shown a flight response to boats occurs at a distance of around 500 m (Anderson *et al*., 2012).

14.6.153 From the Main Site, there is a spit of land which encompasses Seal Sands. The topography of the spit means that direct line of sight to the haul-out site from the Main Site is extremely limited and so construction works on the south side of the river are not predicted to cause any visual disturbance to seals hauled out at Seal Sands.

14.6.154 The Tees Estuary is a highly industrialised area with regular marine vessel traffic. Furthermore, the area is frequently visited by members of the public to watch the wildlife (i.e. seals and birds) within the area. It can therefore be expected that seals and other marine mammals which occupy the estuary and surrounding area (such as the Tees Bay) would be habituated to anthropogenic sources of visual stimuli. Furthermore, vessel activities as part of the Proposed Development, would be operating in the Tees Bay, away from the Seal Sands haul-out site (approximately 3 km).

14.6.155 Considering this and the temporary, localised and intermittent nature of any changes in visual stimuli arising as a consequence of construction of the Proposed Development, effects to marine mammals, including harbour seals, which are a feature of the Teesmouth and Cleveland Coast SSSI, are predicted to be Not Significant.

Introduction and Spread of Invasive Non-Native Species

14.6.156 INNS have the potential to out-compete native species with possible detrimental impacts to native habitats via species loss, modifications to ecosystems and the introduction of disease and pathogens leading to mortality.

14.6.157 Marine vessels required for construction of the Proposed Development represent the most likely pathway for the introduction of INNS, either from biofouling or from the discharge of ballast water and bilge water. Vessels on site will include survey vessel(s), dredger(s), and workboat(s) and / or barge(s) (e.g. jack-up barges and rigid inflatable boats (RIBs)). The exact number and vessel specifications to be used as part of the Proposed Development is yet to be determined.

14.6.158 However, INNS may potentially be introduced via construction materials (e.g. placement of rock armouring required around either the existing or replacement outfall). The introduction of hard artificial structures also has the potential to facilitate the colonisation of INNS as these are known to disproportionately favour non-native species compared to naturally occurring hard-bottom species due to the absence of competition and predation (Witt *et al.,* 2012). New substrates or structures can also serve as ‘stepping stones’ in otherwise unhospitable areas, which can assist with the expansion of species distributions (Mineur *et al*., 2012). The rock armouring / scour protection to be used at the outfall head will, in a worst-case scenario, represent a volume of 250 m^3.

14.6.159 With the implementation of the good practice mitigation measures outlined in paragraphs 14.5.10 and 14.5.11, the risk of introduction and spread of INNS through ballast water exchange and biofouling would be reduced and therefore the probability of transmission is low. Given the relatively small volume of rock armouring (a predicted maximum 250 m^3) which would be required to protect the outfall head, the risk of INNS transmission on this material is also low.

14.6.160 The prevalence of existing INNS within the vicinity of the Site is limited and none appear to be detrimental to native species habitats, diversity or ecosystem functioning (see Section 14.4). Given the limited extent of loss and physical disturbance to habitats and species, and volume of artificial substrate

added during construction, the risk of existing or new INNS becoming established or proliferating to an extent that would cause ecological harm is considered to be very low. Thus, the effects to marine ecological receptors are predicted to be Not Significant.

Collisions Between Project Vessels and Marine Mammals

14.6.161 Moving marine vessels and plant have the potential to collide with marine mammals. This may result in physical injury, such as propeller injuries, and in the worst-case, mortality (Pace *et al*., 2006; Dolman *et al*., 2006).

14.6.162 Should refurbishment or replacement of the outfall be required, in addition to construction of the CO_2 Export Pipeline, there is potential for several marine vessels to be operating within the wider Tees Bay. The exact number and types of vessels required is not currently known although these can be expected to include survey vessel(s), dredger(s), and workboat(s) and / or barge(s) (e.g. jack-up barges and RIBs). The frequency of vessel movements and the level of marine traffic is also yet to be determined but as a worst-case scenario it is assumed that vessels may be operating at the same time.

14.6.163 Marine mammals, particularly cetaceans, are considered to be fast swimming, agile species, with fast reflexes and good sensory capabilities (Hoelzel, 2002). However, individuals can become distracted during important activities such as foraging and social interactions, and therefore may not perceive the threat of an approaching vessel (Wilson *et al*., 2007). Locally resident species such as harbour and grey seals, which use haul sites within the Tees Estuary, are likely to be habituated to marine vessel movements although juvenile seal pups which are inexperienced in the water, and more inquisitive species such as the bottlenose dolphin, would be expected to be vulnerable.

14.6.164 Marine mammals possess a thick subdermal layer of blubber which provides a level of protection to their vital organs meaning they are reasonably resilient to minor strikes and collisions (Wilson *et al*., 2007). However, a direct strike from a sharp object such as rotating propeller blades has potential to cause lethal injury to marine mammals and several cases of seal injuries thought to be caused by propellers and thrusters (for dynamic positioning of vessels) have been recorded in recent years (Bexton *et al*., 2012).

14.6.165 The most lethal and serious injuries to marine mammals are believed to be caused by large ships, typically 80 m and longer as well as vessels travelling faster than 14 knots (Laist *et al*., 2001).

14.6.166 The majority of vessels potentially required for construction of the Proposed Development will be <80 m in length, slow moving (i.e. operational speeds of <14 knots) and will be stationary for long periods of time within discrete work areas (i.e. proximity to the outfall and onshore CO_2 Export Pipeline location). Other vessels, such as work boats, have a shallow draught and will be operating close inshore which means the potential for collision with marine mammals would be limited.

14.6.167 RIBs or similar vessels have the capacity to travel at high speeds although the number required during construction is expected to be limited. Furthermore, their movements would generally be limited to within the

immediate vicinity of the Site and speeds within the Tees Bay would be limited by restrictions imposed by the local port authority.

14.6.168 With the exception of harbour and grey seals, the abundance of marine mammals within the immediate vicinity of the Site is predicted to be low. However, most vessels will be operating in the Tees Bay, away from the Seal Sands haul-out site (approximately 3 km), where abundances of harbour and grey seals are expected to be lower. Given the likely occurrence of other disturbance effects (e.g. underwater sound disturbance), displacement of individuals is also probable.

14.6.169 Overall, the likelihood of marine vessels colliding with marine mammals is predicted to be low but a small risk to juvenile seal pups is considered to remain. Any effect would occur at the local level with no impact to wider species populations or the conservation status of species at the management unit level). As such, effects to marine mammals including harbour seals, which are a feature of the Teesmouth and Cleveland Coast SSSI, are predicted to be Not Significant.

Loss or restricted access to commercial fishing grounds

14.6.170 Marine vessels used during the construction phase of the Proposed Development have the potential to result in the temporary loss of, or restricted access to, commercial fishing grounds.

14.6.171 Works associated with the construction of the water discharge connections, such as the refurbishment or replacement of the outfall, will require a series of marine vessels transiting and operating within the Tees Bay. The vessels expected to be used include survey vessel(s), dredger(s), and workboat(s) and / or barge(s) (e.g. jack-up barges and RIBs).

14.6.172 The timing of the construction activities, when the vessels will be present, and the length of time that they are present will determine the impact on commercial fisheries. If the construction activities coincide with key fisheries seasons (which varies by species), this has the potential to result in the restriction or loss of access to key fisheries grounds. The sensitivity of different commercial fisheries fleets to works will be dependent on their home port, the geographical location of and route to their usual fishing grounds and their potential to use alternative grounds. The closest home port to the Proposed Development is in Hartlepool.

14.6.173 In the Tees Bay, vessels such as workboats / jack-up barges and dredgers, have the potential to restrict access to this area for commercial fishing. It is thought that this area would be mainly used for potting and trapping by a limited number of smaller vessels (10 m and under) (Smith, pers. comms., 2021). Larger fishing vessels (10 m and over) may use the Northernmost area of the Tees Bay but as much of the area to the east of the mouth of the estuary and South Gare is non-navigable for larger vessels, they are highly unlikely to access the majority of the inner Tees Bay. The overall, the density of commercial vessels in this area is considered to be low (Smith, pers. comms., 2021).

14.6.174 Vessels used for works in the Tees Bay would only be present for a temporary period of time. For example, the use of workboats / jack-up barges

to install the discharge tunnel and outfall head as part of the outfall is predicted to be less than 26 weeks (although the exact duration is currently unknown).

14.6.175 Given the short and temporary nature of any loss of access to commercial fishing grounds, and the relatively low importance of the area for fishing, the potential effects from the use of marine vessels and plant as part of the Proposed Development is considered to be Not Significant.

Displacement of commercial fishing activities

14.6.176 Any loss or restricted access to commercial fishing grounds could result in increased competition if these vessels are displaced to alternative grounds and fisheries resources. However, any area lost or restricted as a result of the Proposed Development would be small and therefore unlikely to result in the displacement of commercial fishing vessels. Furthermore, if there was any displacement, this would only be temporary, meaning fishing vessels would return following the removal of any marine vessels and plant used during the construction phase. Overall, the potential for works associated with the Proposed Development to result in the displacement of commercial fishing activities is Not Significant.

Obstruction of navigation / steaming routes to commercial fishing grounds

14.6.177 The presence of marine vessels could result in the temporary increase in steaming distances and times for commercial fishing vessels to avoid these. This could lead to increased operational costs of the fishing vessels.

14.6.178 As above, the Tees Bay is not considered to be a particularly active area in terms of commercial fishing and therefore any vessels present as part of the construction of the Water Discharge Connection would be unlikely to increase steaming distances of commercial vessels. Furthermore, a large proportion of the Tees Bay will remain in-use and be unaffected, meaning that commercial fishing vessels will still be able to pass and therefore any increase in steaming distances would be negligible.

14.6.179 Further detailed consideration of Navigational Risk is provided within Appendix 20B: Navigational Risk Assessment (ES Volume III, Document Ref. 6.4).

14.6.180 Overall, the impact from the obstruction of navigation / steaming routes to commercial fishing grounds from the Proposed Development is considered to be negligible and therefore the effect is Not Significant.

Indirect effects on commercial fisheries

14.6.181 There is potential for any works associated with the Proposed Development to indirectly impact commercial fisheries as a result of impacts on the behaviour and distribution of fish. For example, changes in the underwater soundscape during the construction phase may result in behavioural responses in individuals of fish and shellfish which are of commercial importance and are fished in the vicinity of the Proposed Development. For the purpose of this assessment, any impact pathways on the receptor fish and shellfish are also considered to be the same for the receptor commercial fisheries.

14.6.182 The assessment of potential effects to fish and shellfish have been completed in in Section 14.6, whilst a list of impact pathways for this receptor are included in Table 14-6. Overall, no significant effects to fish and shellfish were identified as a result of the Proposed Development, and therefore the indirect effects on commercial fisheries is Not Significant.

Operational Phase

Thermal Effects from Treated Water Discharge

14.6.183 The discharge of treated effluent can influence a variety of marine organisms including plankton, benthic habitats and species as well as fish, shellfish and INNS. Long-term effects can include changes in biological processes (e.g. growth, spawning, etc.), mortality, displacement and changes in species' community composition and distribution.

14.6.184 Marine mammals can be indirectly affected by shifts in the distribution of food resources if, for example, prey species are attracted or deterred by the warmer waters around the outfall. The elevated temperatures which may be found at the release point from the outfall – or the 'thermal plume' - may also act as barrier to fish migration.

14.6.185 In order to inform the assessment of potential effects arising from CWS operations, engagement with the MMO and the Environment Agency was undertaken to set out the specification, scope and approach to thermal modelling. This included a modelling-specific discission and circulation of a modelling scope memo in March 2020 in-advance of completion of the initial modelling exercise.

14.6.186 The Environment Agency response to Stage II consultation included technical feedback related to the modelling exercise; this was subsequently discussed with the Environment Agency in January 2021. During this engagement, the Environment Agency recommended that additional (far-field) modelling be undertaken.

14.6.187 Following this engagement, the existing near-field modelling was refined and additional far-field modelling completed; Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4) provides full details of the modelling undertaken. The modelling was undertaken for both outfall scenarios; the discharge point at the northern extent of the existing outfall, and the replacement outfall to the south east (described in Appendix 14 E as 'Outfall 1' and 'Outfall 2', respectively. To construct the thermal plume simulations as part of the near-field modelling, the MixZon Inc. CORMIX modelling software was used. The far-field modelling was undertaken to determine the impact of the thermal discharge produced by CWS operations into the sea off the Teesside coastline, and used the Delt3D hydrodynamic model.

14.6.188 Modelling for the existing outfall was based on an approximate location for the discharge of treated effluent adjacent to the existing former Redcar Steelworks outfall and within the water discharge corridor.

14.6.189 Conditions at the location of the replacement outfall are understood to be very similar in terms of bathymetry, wave behaviour, wind effects and temperature. At this stage, the exact location of the discharge point cannot be

confirmed as it is reliant on a number of different interlinking engineering, logistical and programme factors which will be confirmed at a later date. For this reason, a selection of different potential discharge points have been considered with an approximate mid-point discharge location carried forward for modelling, as a worst-case. In addition, at both the existing and replacement outfalls, sensitivity analysis has been undertaken to consider changes to the outfall head position.

14.6.190 The set-up for both the near-field and far-field modelling, including the ambient conditions at each outfall location, the key characteristics of the effluent water body, the geometrics of the discharge point, and the results of the sensitivity analysis is discussed in full detail within Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4). The approach to modelling has been discussed via a series of technical engagement meetings with the Environment Agency in March 2019, January 2021 and February 2021. It has been assumed at both the existing and replacement outfall, that the characteristics of the effluent will be a temperature excess of 15°C, a flow rate of 1.37 m^3/s and a density of 1,018 and 1,020 kg/m^3 to represent summer and winter conditions, respectively. The outfall pipe at both locations was assumed to measure 0.8 m in diameter and located 1 m above the seabed with the outlet orientated in the vertical plane (i.e. pointing upwards). Notwithstanding, for the replacement outfall, an additional sensitivity test case was developed whereby the outfall was 2.4 m in diameter; this was considered in order to assess the potential combined use of the outfall for surface water and treated effluent including during a 1-in-30 year storm event. The full details of this sensitivity are provided in Section3 of Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4).

14.6.191 For all of the thermal modelling undertaken, the reporting is highly precautionary for several specific reasons. For example, the parameters defined at the start of the modelling process were based on three Combined Cycle Gas Turbine (CCGT) ‘trains’; as the Proposed Development is now only for a single CCGT ‘train’, the modelling assumptions are highly precautionary. Furthermore, any performance benefits from the presence of a terrestrial mixing zone (i.e. surge pit / outfall retention pool) before discharge of treated effluent to the outfall have not been factored in. For this reason, no losses of heat to the atmosphere or through mixing with other water sources (i.e. surface water) were factored in (again, highly precautionary). In addition, all of the modelling undertaken is based on a poorly-performing outfall head with no diffuser fitted; as noted in Chapter 5: Construction Programme and Management (ES Volume I, Document Ref 6.2). Owing to the relatively low discharge volumes proposed and to assist the dissipation of any plume, a diffuser at the outfall head will be retrofitted by the landowner if the existing diffuser is no longer functional. Similarly, in the event that a replacement outfall is required, a diffuser head would be installed, as required. Details of the diffuser for either outfall cannot be confirmed at this stage and therefore have not been used to inform the modelling however, this feature would help improve the performance of the existing outfall or replacement outfall locations.

14.6.192 Following a range of sensitivity tests as part of the near-field modelling, the largest thermal plume extent at the existing outfall was found to be during

a spring tidal range under summer conditions. At the replacement outfall, the largest plume was identified for a neap tide under normal discharge conditions, due to tidal velocities reducing the rate of dispersion of the excess temperature. Diagram 14-2 and Diagram 14-3 present the extent of the excess temperatures isolines from +0.1 °C to +5°C under the conditions which provided the largest plume at both the existing and replacement outfalls, respectively. This information is also shown in Table 14-18 and Table 4-19. These modelling results have been considered in relation to the impact pathways on water quality and the Tees Coastal waterbody in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

Diagram 14-2: CORMIX Excess Temperature Isolines (°C) Under Mean Spring, Peak Flood (Southeast) and Ebb (North West) Tidal States, at the Existing Outfall

Diagram 14-3: CORMIX Excess Temperature Isolines (°C) During Neap Tide Under Normal Discharge Conditions, at the Replacement Outfall

14.6.193 There are no legal standards for limits on thermal discharges into coastal water bodies. The most recent guidance available was developed by the British Energy Estuarine & Marine Studies (BEEMS) Expert Panel who produced a report: *Thermal standards for Cooling Water from new build nuclear power stations*, which summarises existing temperature standards and provides evidence on the effects of thermal discharges (BEEMS, 2011). This work was expanded by Wither *et al*. (2012) in a review of the thermal tolerances of fish and marine biota and recommended thresholds in relation to WFD status boundaries. These are defined as high, good, moderate, poor and bad, where the aim is for all water bodies to achieve good. The normative boundary definitions (as an annual 98 percentile) proposed by BEEMS (2011) include a +2°C temperature uplift for a WFD classification of High / Good and +3°C uplift for all subsequent classifications (Good / Moderate, Moderate / Poor and Poor / Bad).

14.6.194 Based on the +2°C and +3°C temperature boundaries, the modelling results for the existing outfall predict a maximum extent of 1,673 m^2 and 71 m^2, respectively (see Table 14-18). Thus, under spring conditions (when the thermal plume is predicted to be largest under this scenario), the likely extent of thermal plume would be very localised with a 2°C temperature excess extending no more than 107 m on the flood tide and 140 m during the ebb tide.

14.6.195 At the replacement outfall, the likely extent of thermal plume during neap tides (when the thermal plume is predicted to be largest under this scenario) with a 2°C temperature excess, extended to 599 m and 398 m during the flood and ebb tide, respectively (see Table 4-19). Although these distances are greater than at the existing outfall, these are still considered to be localised

within the Tees Bay. At both the existing and replacement outfalls, these distances are further reduced when considering a 3°C temperature excess.

Table 14-18: Excess Temperature Isoline Extents from the Existing Outfall for a Mean Spring Tide Under Peak Flood and Peak Ebb Conditions

Excess temperature isoline (°C)	Peak flood tide		Peak ebb tide	
	Isoline extent from outfall (m)	Area of excess temperature (m^2)	Isoline extent from outfall (m)	Area of excess temperature (m^2)
5.0	1.6	32	61.3	2
4.0	6.6	49	79.4	3
3.0	44.7	71	97.6	21
2.0	106.5	1,673	140.0	76
1.0	179.3	7,500	235.4	1,455
0.1	754.2	81,256	718.1	74,758

Source: see Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4).

Table 14-19: Excess Temperature Isoline Extents from the Replacement Outfall for all Tidal States Under Normal Discharge Conditions

Excess temperature isoline (°C)	Spring Flood Tide	Spring Ebb Tide	Neap Flood Tide	Neap Ebb Tide
	Isoline extent from outfall (m)	Isoline extent from outfall (m)	Isoline extent from outfall (m)	Isoline extent from outfall (m)
5.0	5	117	237	149
4.0	57	146	329	203
3.0	114	184	431	293
2.0	170	266	599	398
1.0	308	381	913	609

Source: see Appendix 14E: Coastal Modelling Report (ES Volume III, Document Ref. 6.4).

14.6.196 Whilst the near-field modelling demonstrates that there is a minimal ZoI arising from the plume even when precautionary assumptions have been used for the model inputs, following discussions with the Environment Agency in January 2021, far-field modelling was commenced. Discharge from both the existing and replacement outfalls was simulated as part of the far-field assessment for a range of environmental conditions.

14.6.197 The Delt3D hydrodynamic model shows a small impact on ambient water temperatures, with depth averaged temperature differences of >0.02°C detected up to approximately 9 km from the replacement outfall. However, greater temperature excesses of up to 0.3°C were localised to within 1.5 km of the outfall for all simulations.

14.6.198 The extent of the thermal discharge at the replacement outfall was greater than that simulated at the existing outfall. This was likely due to consistently greater flow speeds at the existing outfall, potentially resulting in the faster dispersion of the plume. However, in some scenarios the thermal plume from the existing outfall was seen inside the mouth of the estuary and

sometimes extending into the Tees Estuary. This was not observed at the replacement outfall. Despite this, the temperature excess did not exceed 0.06°C in summer in the neap simulation, where it was seen in the mouth of the Estuary. In the winter spring tide simulation, where the plume extended into the Tees Estuary, the temperature excess was below 0.04°C.

14.6.199 The temperature excesses identified as part of the far-field modelling are considered to be very small compared to the background of 9.9°C (annual average), and therefore is considered to represent a negligible change in ambient water temperatures. The following assessments consider the locations of the +2°C and +3°C temperature boundaries identified from the CORMIX modelling as well as other receptor-specific thresholds where available.

14.6.200 Detailed discussions with the Environment Agency and responses to consultation requested that consideration be given to the potential cumulative effects associated with the discharge of treated effluent from the Proposed Development. An examination of publicly available data within the vicinity of the Proposed Development has been completed which has identified that the majority of treated effluent discharges occur further inside the Tees Estuary or do not have any thermal uplift. The closest outfall with a thermal uplift is the CWS discharge pipeline and outfall head for Hartlepool Power Station (HPS), a direct-cooled Nuclear Power Station owned and operated by EDF which is approximately 5 km to the north-west of the outfall.

14.6.201 Detailed data related to the specific operational parameters of the HPS is not publicly available and as such, details of the discharge (such as maximum volumes and uplift) was requested through the Environment Agency in January and March 2021; no response was received. In the absence of this information, a quantitative appraisal (i.e. modelling) was not possible and the assessment therefore provides a qualitative appraisal of potential cumulative (thermal) effects.

14.6.202 The discharge from a direct-cooled power station such as HPS is expected, based on the age and location of the station, to be within the region of 75-100 m^3/s with a potential thermal uplift of up to 18°C. Based on the modelling undertaken for the Proposed Development, there may be some overlap between the HPS discharge and the thermal plume from either the existing or replacement outfalls, although this is only likely to be around the extremities of the plume (i.e. where the temperature excess is <0.2°C). When this highly limited temperature excess is reviewed against the context of the discharge associated with HPS and natural variability, it is considered that there would be no discernible change in marine effects. The specific assessment of cumulative effects of thermal discharges is therefore screened out of further discussion within this assessment. Further details related to the wider assessment of cumulative and in-combination effects is provided within Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2).

Plankton

14.6.203 Plankton have limited mobility and their distribution is governed by external factors including the hydrodynamic regime and degree of vertical mixing within the water column. Primary production can be enhanced by

increased water temperatures although localised effects are usually hard to detect in coastal waters owing to the patchiness of plankton concentrations.

14.6.204 Given the highly limited predicted extent of the thermal plume in both outfall scenarios and the apparent degree of mixing, it is unlikely that the planktonic community would be exposed to a temperature increase that would affect their metabolic rate or productivity, even within the immediate vicinity of either outfall. Any effect is therefore unlikely to impact the wider abundance and diversity of plankton communities. The magnitude of impact to plankton from thermal discharge through the outfall is predicted to be negligible and the effects Not Significant.

Intertidal Habitats and Communities

14.6.205 Intertidal habitats and species are naturally exposed to a greater degree of thermal stress than subtidal species, as they are periodically exposed to elevated temperature and desiccation when exposed during low tide.

14.6.206 The intertidal area within the vicinity of both the existing and replacement outfalls is known to support a low abundance and diversity of macrofauna with few species of macroalgae present (see Appendix 14A: Intertidal Benthic Ecology Survey Report, ES Volume III, Document Ref. 6.4). Based on the MarLIN MarESA[12], all intertidal habitats and associated communities within the footprint of the thermal plume are considered to be highly resistant and resilient to local temperature increases.

14.6.207 Based on the results of the thermal modelling, there is predicted to be limited interaction between the thermal plume and intertidal habitats and so the magnitude of impact is predicted to be small and highly localised. Thus, effects to intertidal habitats and species are predicted to be Not Significant.

Subtidal Habitats and Communities

14.6.208 Subtidal organisms are naturally less adapted to wide fluctuations or increases in temperature than those in intertidal communities, and as a result are possibly more susceptible to the effects of thermal stress.

14.6.209 As shown in Table 14-18 and

14.6.210 Table 14-19, the extent of the thermal plume within the water column at both the existing and replacement outfalls will be highly localised, despite extending further for the replacement outfall option. Even when considering a small temperature uplift of 1°C the thermal plume is predicted to extend approximately 913 m and 609 m, for a mean neap tide under peak flood and ebb conditions, respectively. For the existing outfall, this is predicted to be 179 m and 235 m for a mean spring tide under peak flood and ebb conditions, respectively. Thermal effluent generated by the Proposed Development will be naturally buoyant (due to lower salinity and the lower density of warmer water) and therefore the footprint of the thermal plume on the seabed will likely be further reduced.

14.6.211 The dominant habitat which is expected to be present within the vicinity of the treated effluent outfall is '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. According to MarESA, this habitat has a low sensitivity to local temperature increases, which for the purpose of this assessment was considered to be a

2°C increase for one year (Tilin and Rayment, 2016). As such, they are considered to be reasonably tolerant of a chronic 2°C uplift although some sub-lethal effects such as changes to the timing of gametogenesis and spawning may occur at higher temperature increases (i.e. within tens of metres of the outfall).

14.6.212 Given the results of the thermal modelling and the sensitivity of species known to be present, discharge of treated effluent during operation of the Proposed Development is not predicted to have any discernible impact on the subtidal habitats and the abundance, distribution and diversity of associated species beyond the immediate vicinity of both outfall options. The magnitude of impact is therefore predicted to be small and highly localised and thus the effects to subtidal habitats and species are predicted to be Not Significant.

Invasive Non-Native Species

14.6.213 During baseline surveys, wakame (*Undaria pinnatifida*) was reported as the only INNS currently known to be present and growing within the Study Area. This intertidal macroalgae is a species of kelp which originates from Japan and due to its rapid growth is known to outcompete native species within rocky reef habitats (GB NNSS, 2020).

14.6.214 The growth of wakame is stimulated by reduced, rather than increased, temperatures, with persistent colder conditions below 15°C promoting recruitment and growth (Thornber *et al*., 2004). Thus, discharge of treated effluent is not predicted to exacerbate growth of this species within the vicinity of the Proposed Development.

14.6.215 It is possible that some INNS which are present in the surrounding waters, that are adapted to warmer water, could become established in the vicinity of the outfall during operation. The baseline for non-native species will continue to evolve during the construction phase and therefore it is not possible to accurately predict the species that could become established.

14.6.216 Overall, the risk that treated effluent, and associated thermal plume, arising from the Proposed Development could facilitate introduction and spread of INNS during operation is considered to be low. The effect on native habitats and species from the establishment of non-natives linked to the thermal plume is therefore predicted to be Not Significant.

Fish and Shellfish

14.6.217 Depending on the species, increases in sea temperature may have a positive, negative or neutral effect on fish and shellfish. Effects are likely to include thermal avoidance or attraction, changes in growth rate or the modification of community structure.

As shown in Table 14-18 and

14.6.218 Table 14-19, the extent of the thermal plume from both the existing and replacement outfalls, is considered to be highly localised. When considering the results from far-field modelling, the extent of the plume is larger however, under none of the scenarios modelled is there a temperature excess greater than 0.06°C into the Estuary mouth. In all scenarios modelled, the higher temperature excess is limited to the immediate area surrounding both the existing and replacement outfalls. For example, a 5°C temperature excess -

the highest excess isoline - extends a maximum of 61.3 m from the existing outfall and a maximum of 237 m from the replacement outfall (both neap flood tide events).

14.6.219 Considering this and the predicted temperature increase, the exposure of fish and shellfish (namely demersal life stages and species such as sandeels) to the thermal plume is highly unlikely to result in changes to communities in terms of abundance and diversity owing to the negligible change in sea temperature. The thermal plume is also not predicted to affect the reproductive success of fish species of conservation and / or commercial importance nor would it represent a barrier to migratory species.

14.6.220 As noted above, the temperature excess isolines which extent into the Estuary are negligible, being <0.06°C in all scenarios modelled, with the higher temperature excess isolines never entering the Estuary. As the majority of the extent of the thermal plume is away from the mouth of the Estuary and as there are only negligible increases in the Estuary itself when considered against ambient water temperatures, this would not represent a barrier to migratory routes for diadromous fish species.

14.6.221 Thus, the magnitude of impact is predicted to be negligible and the effect on fish and shellfish from thermal discharge is predicted to be Not Significant.

Marine Mammals and Designated Sites

14.6.222 Marine mammals are physiologically adapted to regulate their body temperature. Although the increase in water temperature in the vicinity of the discharge may be noticeable to those marine mammals known to occupy inshore areas (e.g. seals), this would be within the natural temperature range that would be experienced by these species (e.g. when diving and moving between coastal and estuarine waters or, in the case of seals, when hauling-out). Thus, direct effects to marine mammals from the discharge of thermal effluent, including harbour seals which are a feature of the Teesmouth and Cleveland Coast SSSI, are predicted to be Not Significant.

14.6.223 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals, including harbour seals which are a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be Not Significant.

Chemical Effects from Discharge of Treated Effluent

14.6.224 During operation, there is potential for treated effluent to be discharged to the Tees Bay which may result in changes to marine water quality, leading to indirect effects to marine ecology.

14.6.225 It is proposed that water from the direct contact cooler blowdown will be sent to an on-site effluent treatment plant where it will be subject to biological treatment. The treated process effluent will then be transferred along with other process water streams to a retention pond before being discharged to the Tees Bay. Alternatively, if off-site treatment for blowdown is required, above ground outward and return flow pipelines to Bran Sands Wastewater Treatment Works will be constructed. Following this, treated water may be returned from Bran Sands to the PCC Site in a separate pipeline for use and/or discharge via the existing or replacement outfall.

14.6.226 The proposed wastewater treatment system is designed to achieve compliance with Environmental Permitting Requirements. However, regular sampling of the treated effluent prior to discharge will be carried out to monitor compliance. The retention pond will also be designed with sufficient capacity to hold treated effluent for approximately eight hours should any quality issues be identified, thereby further reducing the risk of non-compliance.

14.6.227 Given the information presented above, the low predicted rate of treated effluent which will be discharged to the Tees Bay (i.e. a total worst-case discharge rate of 1.37 m^3/s) and the open nature of the coastline where hydrodynamic conditions are expected to facilitate rapid dispersion, the potential for adverse effects to marine water quality is considered to be low. Furthermore, the effluent will need to demonstrate compliance with the relevant EQS for each component of the effluent and be regulated fully under the Environmental Permit for discharge. As such, the assessment in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2) has concluded a minor adverse non-significant effect to marine water quality.

14.6.228 Whilst the impact would be permanent, a localised deterioration in marine water quality within the vicinity of the outfall is not predicted to result in any detectable effects to marine species or habitats, nor to biodiversity or the conservation objectives for any marine species or designated site. As such, the effects to marine ecological receptors from wastewater discharge are predicted to be Not Significant.

14.6.229 This conclusion is based on the current preferred design for the on-site wastewater treatment facilities, using assumptions which are a worst-case. As noted above, detailed discussions have been undertaken with the Environment Agency regarding the operation of the Proposed Development, including to support the Environmental Permit application. The effluent will need to demonstrate compliance with the relevant EQS for each component of the discharge and will be subject to the site/effluent-specific controls set by the permitting authority; this will be determined through the Environmental Permit application process.

Effects to Intertidal Habitats and Species (Including Fish) From the Deposition of Airborne Pollutants

14.6.230 Deposition of air pollutants released from point source emissions can be deposited into the marine environment either by wet or dry deposition processes. Deposition of air pollutants, particularly nitrogen (and sulphur) compounds can cause direct disturbance to marine habitats and species through acidification and eutrophication (Pacyna, 2008), as well as fish species which may depend on these habitats for specific functions (e.g. nursery grounds).

14.6.231 The single Carbon Capture Unit (CCU) absorber stack is considered to be a potential source of nitrogen deposition from the Proposed Development, in the form of Nitrogen Dioxide (NO_2) and Ammonia (NH_3). The air quality assessment presented in Chapter 8: Air Quality (ES Volume I, Document Ref. 6.2) has identified this to represent a potential air quality impact on coastal habitats including sand dune and saltmarsh habitat for which the Teesmouth

and Cleveland Coast SSSI and the Teesmouth NNR are designated and which support the interest features of the SPA / Ramsar site.

14.6.232 This assessment forecasted that nitrogen deposition resulting from the Proposed Development would be approximately 2% of the lower value of the Critical Load threshold (20-30 kg N/ha/yr) for littoral habitats (coastal saltmarsh and saline reedbed habitat; EUNIS A2.53, A2.54, A2.55)[17] relevant to the Teesmouth and Cleveland Coast SSSI at the closest areas surrounding the plant. This 1% of the Critical Load threshold is considered by Natural England and the Environment Agency air quality specialists to be an indicator of potential significant atmospheric pollution impacts which require further analysis. However, this is a precautionary level above which, although not insignificant, is insufficient to determine adverse effects. Furthermore, average background nitrogen deposition in the Teesmouth and Cleveland Coast SSSI is 11.2 kg N/ha/yr (ASIP, 2020), meaning that with additional inputs from the Proposed Development, the level of deposition is still below the lower Critical Load threshold.

14.6.233 Dispersion modelling, which takes into consideration recent meteorological data and any buildings, structures, and local topography which may affect dispersion, indicates that nitrogen deposition from the Proposed Development will be at its peak in the area of Coatham Sands. In particular, the predominant wind direction will affect where deposition occurs. This area of Coatham Sands includes the intertidal mudflats and sandflats in the marine environment. Despite this, the hydrodynamic conditions and the open nature of the coastline mean that this area is subject to frequent tidal washing. This will facilitate the rapid dispersion of nitrogen deposits and therefore the potential for adverse effects to intertidal habitats is considered to be low.

14.6.234 Given that tidal washing will remove any deposited nitrogen from the Proposed Development within the intertidal zone, the impacts on intertidal habitats and species from air pollution during the operational phase are considered to be negligible and therefore the effects are predicted to be Not Significant.

Changes in the Airborne Soundscape During Operation

14.6.235 As outlined in paragraph 14.6.133, a change in the airborne soundscape has the potential to disturb pinnipeds (i.e. seals) that have surfaced or have hauled out.

14.6.236 The assessment of operational noise levels has been based upon calculations taking account of proposed plant equipment (see Appendix 11B: Operational Noise Appendix in ES Volume III, Document Ref. 6.4), sound power levels (Lw) and sound pressure levels (SPLs) relating to the proposed plant, the distance between the proposed plant and receptors and the acoustic screening and absorption offered by the existing topography and existing buildings.

14.6.237 The carbon capture plant noise sources, including the HP Compressor, CO_2 Absorber stack exhaust (at the point of emission to atmosphere) and carbon capture plant will be designed so that they do not individually exceed

[17] It must be noted that the list of Critical Load threshold values for marine habitats, provided by the Air Pollution Information System (APIS, 2020), only includes coastal saltmarsh and saline reedbed habitat (EUNIS A2.53, A2.54, A2.55).

a maximum sound pressure level of 85 dB LAeq,T at 1 m external to the building/ plant. This will potentially overestimate the sound power level, but is intended to represent a reasonable worst-case assessment.

14.6.238 The sound power level for the main tower of the CO_2 Absorber has been modelled based upon the Absorber being an open structure producing a sound pressure level of 77 dB L_{Aeq},T at 1 m. The Absorber stack exterior (adjacent to the stack casing rather than at the point of emission to atmosphere) has also been modelled as radiating a sound pressure level of 77 dB L_{Aeq},T at 1 m. The Direct Contact Cooler has been included with sound power level data from a similar Carbon Capture Usage and Storage (CCUS) project, however, this is not anticipated to be a significant source of noise.

14.6.239 For operational activity, only A-weighted sound levels (being the most appropriate model for human, and therefore mammal, hearing) are available. Further details on the prediction methodology can be found in Chapter 11: Noise and Vibration (ES Volume I, Document Ref. 6.2).

14.6.240 The worst-case air-borne sound pressure levels are 85 dB LAeq,T at 1 m external to the building/ plant. The closest part of the Seal Sands mudflat which has been found to be used by seals (i.e. 'Site D', see Diagram 14-1 above) is approximately 3 km to the west of the PCC Site. On this basis, the A-weighted sound exposure level at the mudflats is predicted to

14.6.241 considerably less than the 134 dB and 154 dB re $(20\ \mu Pa)^2$s onset threshold for TTS[18] and PTS[19] respectively, which uses phocid-specific weightings (Southall *et al.*, 2019). As the predicted A-weighted sound exposure level is less than the onset threshold for TTS, and given that the two weightings are relatively similar (see paragraph 14.6.139), it is considered that the sound pressure levels produced by operational activities will not exceed the onset threshold for TTS and PTS given in Southall *et al*. (2019), even when taking into account baseline conditions.

14.6.242 Thus, it is considered very unlikely that seals hauled out at Seal Sands would be vulnerable to auditory damage due to changes in the airborne soundscape during operation. Using the TTS threshold as a proxy behavioural threshold, the risk of behavioural disturbance is also considered to be negligible.

14.6.243 In light of this, there is considered to be highly limited potential for detectable changes in the abundance, distribution and conservation status of harbour and grey seals as a consequence of changes to the airborne soundscape during operation. Thus, effects to seals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI) are predicted to be Not Significant.

Loss of commercial fishing grounds

14.6.244 The emplacement of the outfall head and installation of the associated rock armouring / scour protection may present an obstruction on the seabed

[18] Temporary Threshold Shift (TTS) - is a recoverable elevation in hearing threshold (i.e., a non-permanent reduction in hearing sensitivity) most commonly resulting from long-term noise exposure not high enough to cause PTS.
[19] Permanent Threshold Shift (PTS) - is a permanent elevation in hearing threshold (i.e., an unrecoverable reduction in hearing sensitivity). PTS can occur from a variety of causes, but it is most often the result of intense and / or repeated noise exposures.

which could result in the loss of commercial fishing grounds during the operational phase of the Proposed Development.

14.6.245 Obstructions on the seafloor may prevent or limit certain types of fishing gear due to the potential for snagging of the equipment. This will predominantly impact mobile demersal fishing gears, such as trawls and drift nets. Drift nets are particularly susceptible to snagging even on 'clean' fishing grounds.

14.6.246 The only additional permanent infrastructure that will be placed on the seafloor as a result of the Proposed Development, is the installation of a new outfall head and subsequent protection in the form of rock armouring / scour protection in the Tees Bay. As a worst-case scenario, this area would be less than 100 m^2. This represents a relatively small area, meaning that the risk to entanglement and obstruction to fishing gear would be negligible. Furthermore, vessel densities in the area to the east of South Gare are low, because it is predominately non-navigable for larger vessels. The Tees Bay is also considered to be an area of limited potting and trapping, with very small numbers of local fishing vessels (under 10 m) utilising this area (Smith pers. comms., 2021).

14.6.247 Whilst the infrastructure placed on the seafloor would be permanent, the extent of seabed this represents is small (less than 100 m^2) in an area of relatively low commercial fishing activity. Overall, the potential effects from the loss of commercial fishing grounds, as a result of obstructions on the seafloor from the Proposed Development, are considered to be Not Significant.

Displacement of commercial fishing activities

14.6.248 Any loss or restricted access to commercial fishing grounds during the operational phase of the Proposed Development could result in increased competition if these vessels are displaced to alternative grounds and fisheries resources.

14.6.249 As outlined in the previous impact pathway (see paragraph 14.6.244), the loss of fishing grounds in the Tees Bay, as a result of the introduction of the outfall head and subsequent rock armouring / scour protection, would represent a very small area (less than 100 m^2). Furthermore, the commercial fishing activity in this area is considered to be low. Therefore, the risk of any displacement of commercial fishing activities is concluded to be negligible. A large proportion of the fishing grounds in Tees Bay would still be accessible, meaning there would be no requirement to travel to alternative grounds. In light of this, the potential for permanent infrastructure as a result of the Proposed Development to result in the displacement of commercial fishing activities is Not Significant.

Decommissioning Phase

14.6.250 The decommissioning phase is anticipated to consist of the removal of all above ground infrastructure, whilst buried pipeline etc will be left in situ. In the marine environment, it is assumed as a worst-case that the outfall head and diffuser and surrounding rock armouring / scour protection would be removed. However, depending on the chosen outfall option, the infrastructure of either the Water Discharge Corridor or the replacement outfall would remain in place.

14.6.251 It is considered that the introduction of rock armouring / scour protection around the outfall diffuser head may provide artificial reef habitat that may be colonised by flora and fauna. Therefore, the removal of this permanent infrastructure may lead to the direct loss (i.e. removal or mortality) of benthic habitat and the associated species found on this structure. Despite this, there is potential for habitat gains following the removal of these structures and backfilling of the outfall head void as soft sediments would be able to recover within the footprint of this infrastructure and would be available for the colonisation and the re-establishment of habitats and species within this area. It is likely that this area would return to sandflat habitat, which is currently homogenous across the Tees Bay. Overall, the area that this represents is very small (less than 100 m^2) and any changes in the abundance and community structure of benthic habitat and species would be negligible.

14.6.252 Any impact pathways associated with the decommissioning activities are comparable with, or of reduced magnitude compared with the construction phase of the Proposed Development. No significant effects on marine ecology and nature conservation were predicted for construction and therefore are not predicted for the decommissioning phase.

14.6.253 However, at the time of writing this assessment, the relevant ecological features at the time of decommissioning cannot be identified with confidence, given decommissioning would be undertaken nearly 50 years after survey work to establish the pre-construction baseline conditions as reported in this ES Chapter.

14.6.254 Decommissioning activities will be conducted in accordance with the appropriate guidance and legislation at the time of closure of the Proposed Development. A DEMP will be produced and agreed with the Environment Agency and other stakeholders as part of the Environmental Permitting and site surrender process. The DEMP will consider in detail all potential environmental risks and contain guidance on how risks can be removed, mitigated or managed. Ecological surveys will be commissioned as appropriate to inform the scope of the DEMP. This is discussed further within Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2). The DEMP will be secured as a Requirement of the DCO.

14.6.255 On this basis, any likely effects on marine ecology and nature conservation anticipated as a result of the decommissioning phase of the Proposed Development are Not Significant.

14.7 Mitigation and Enhancement Measures

14.7.1 The only significant adverse impact to marine ecology predicted for the construction phase relates to effects on pinnipeds (i.e. seals) and the Teesmouth and Cleveland Coast SSSI from underwater sound disturbance potentially generated by UXO detonations.

14.7.2 No significant adverse impacts to marine ecology during the operational phase are predicted to occur.

14.7.3 The following additional mitigation and enhancement measures have been proposed with the aim of further reducing the magnitude and likelihood of both significant and non-significant effects to marine ecology.

Biodiversity Enhancement

14.7.4 Based on the assessment of worst-case seabed activities (i.e. full replacement of the outfall), there is considered to be no loss of permanent habitat in the intertidal zone and therefore a formal Biodiversity Assessment has not been undertaken. However, a less prescriptive assessment of loss of marine biodiversity under the footprint of permanent structures in the subtidal zone is outlined in paragraph 14.6.22. This identified that no additional biodiversity enhancement measures to offset the loss of subtidal habitat and associated biodiversity, would be required.

Underwater Sound Mitigation Measures

14.7.5 If UXO detonations are required during the project, to minimise the potential for auditory and behavioural disturbance to seals and particularly the harbour seals, which are a qualifying feature of the Teesmouth and Cleveland Coast SSSI, specific mitigation measures will be considered. An assessment of the impact of detonation will be done at the time of discovering UXO with a requirement for a seasonal restriction where noise abatement measures cannot bring the effect down to non-significant. This assessment, and any necessary mitigation, will be secured through conditions included on the draft DML associated with UXO disposal; a DML is provided with the Application in the draft DCO (Document Ref. 2.1).

14.8 Limitations or Difficulties

14.8.1 Any limitations to the collection of field survey data or gathering of based information are identified in the relevant technical appendices that accompany this chapter (ES Volume III, Document Ref. 6.4).

14.8.2 Detailed construction information is not yet available and construction details will be dependent on the condition of existing infrastructure and the requirement for necessary construction works. Therefore, a reasonable set of worst-case assumptions have been identified and assessed within this ES chapter (see Section 14.2) using the Rochdale Envelope principles. There is considered to be sufficient information made available within this Chapter to enable the Examining Authority to make an informed view of the likely significant environmental effects of the Proposed Development.

14.8.3 One limitation which is recognised within the assessment of likely impacts and effects relates to changes in underwater soundscape during the construction phase. The current assessment relies on a simplified geometric spreading underwater acoustic model which applies to shallow water but does not account for the exact physical footprint of the Tees Bay environment and is known to underestimate sound exposure close to the source and overestimate sound levels further away.

14.8.4 Furthermore, there are also limitations with the approach taken to assessing the effects of changes in the airborne soundscape on seals during the construction, commissioning and operational phases of the Proposed Development. However, the current assessment considers the worst-case activity for each phase for the Proposed Development.

14.8.5 The modelling undertaken for changes in both the underwater and airborne soundscape has been undertaken using a precautionary approach. For example, the determination of potential underwater sound impact zones has used geometric spreading calculations for transmission loss, an approach which is known to overestimate far-field effects.

14.8.6 The approach to the assessment of underwater and airborne noise has also been subject to pre-application discussion with the MMO to confirm the appropriateness of the methodology.

14.9 Cumulative Effects Assessment

14.9.1 The potential effects of the Proposed Development, identified within this ES chapter, have the potential to act together with the potential effects of other development schemes (referred to as 'cumulative developments') known to be occurring within the surrounding area. Such interactions can potentially result in cumulative impacts, as discussed below.

14.9.2 The planned developments adjacent to and relevant to the Proposed Development have been listed in Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2). However, many of these developments have been screened out of this assessment as they have been determined to have no potential impact pathways to marine ecological receptors Furthermore, a number of developments have impact pathways on water quality in the Tees Estuary have been considered further in Chapter 9: Surface Water, Flood Risk and Water Resources (ES Volume I, Document Ref. 6.2).

14.9.3 The cumulative developments that are relevant to this assessment due to their potential to interact with the Proposed Development, with respect to marine ecology, are outlined below:

- Net Zero Teesside Offshore Development (ID 1);
- York Potash Harbour Facilities Order, York Potash Limited (PINS Ref: TR030002) (Royal Haskoning DHV UK Ltd., 2015a) (ID 2);
- Dogger Bank Teesside A / Sofia Offshore Wind Farm, Forewind Limited (PINS Ref: EN010051) (Forewind, 2014) (ID 4); and
- Northern Gateway Container Terminal, PD Ports Teesport (R/2006/0433/00) (Royal Haskoning DHV UK Ltd., 2018) (ID 79).

14.9.4 The installation of the NZT CO_2 export pipeline offshore (ID 1) will be subject to a separate consent application and falls within the scope of an assessment for in-combination effects with the Proposed Development – as such, potential combined effects of the onshore and offshore elements of the NZT project are considered below under 'In-Combination Assessment' and in Appendix 24C: Statement of Combined Effects (ES Volume III, Document Ref. 6.4).

14.9.5 The exact timeframes of each activity for these projects is currently unknown, but it is anticipated that the construction and operational phases of these projects could coincide with those of the Proposed Development. The construction of the York Potash Harbour Facilities Order (ID 2) commenced in January 2017 and is to be completed by 2024. The marine construction phase

of the Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4) is due to commence around March 2022 with commissioning and completion before the end of 2024. The construction works for the Northern Gateway Container Terminal (ID 79) are due to be completed by 2028.

14.9.6 As the Proposed Development has an estimated design life of over 25 years for the PCC and 40 years for the CO_2 Gathering Network and HP Compressor, cumulative effects during decommissioning are not considered as it is not possible to predict the developments which would be in progress at that point in time. These will be addressed in the DEMP which will be produced and agreed with the relevant statutory consultees as part of the Environmental Permitting and site surrender process. This is subject to the timeframes of the cumulative developments; a search for new cumulative developments will also be undertaken as part of the DEMP.

14.9.7 The Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4) includes three different elements: Dogger Bank A and B (the offshore wind farm sites) and the Dogger Bank Teesside A and B Export Cable Corridor. The offshore wind farm sites are considered to be too far away (123 km to the closest UK mainland shore) to have cumulative effects when considered alongside the Proposed Development and therefore impact pathways have been considered for the Dogger Bank Teesside A and B Export Cable Corridor, only.

14.9.8 The following marine ecological impact pathways were identified across these cumulative developments:

- Direct loss and physical disturbance to habitat and species;
- Physical disturbance to habitats and species from increased SSC (i.e. turbidity) (including deposition of contaminant remobilisation);
- Changes in underwater soundscape;
- Indirect effects to marine ecology from changes in marine water quality (excluding turbidity) (such as accidental spillages of fuel, and oils);
- Collisions between project vessels and marine mammals;
- Loss or restricted access to commercial fishing grounds;
- Changes to hydrodynamic conditions; and
- Changes in Visual Stimuli (Including Artificial Light).

14.9.9 For the purpose of this assessment, negligible impacts are not considered to have a cumulative impact. Furthermore, impact pathways which are of low risk have also been omitted.

14.9.10 Based on the impact pathways outlined above, potential pathways for cumulative impacts have been identified, which may occur during the construction and operational phase of the Proposed Development. These are discussed further below.

Cumulative Effects during the Construction Phase

Direct Loss and Physical Disturbance to Habitat and Species

14.9.11 All of the above cumulative developments would result in the temporary loss of habitat, both in intertidal and subtidal zones. For the York Potash Harbour

Facilities Order (ID 2) and the Northern Gateway Container Terminal (ID 79) developments, the loss of habitat would occur in the Tees Estuary, consisting of habitat that is representative of the Estuary in terms of sediment type and in faunal communities. Habitat loss from the Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4) would occur to the south east of Tees Bay under the footprint of the wind farm export cable that would be landfall at Marske-by-the-Sea.

14.9.12 For all developments, the majority of habitat loss in the subtidal zone would be temporary and recovery would be expected to occur rapidly following completion, likely within 1-2 years (MarLIN, 2021). Soft sediments, such as those which characterise the benthic ecology Study Area, are known to be highly resilient to direct physical disturbance. Of the cumulative developments, permanent habitat loss is expected to occur in the intertidal zone in the Tees Estuary as a result of the York Potash Harbour Facilities Order (ID 2). The habitat is mud and hard substrata of poor quality.

14.9.13 The permanent loss as a result of the Proposed Development is predicted to be small and in the case of the York Potash Harbour Facilities Order (ID 2), will be representative of a different habitat type (in the subtidal zone). Furthermore, similar habitat types can be found across broader geographical scales, meaning that the area loss (both temporary and permanent) of available habitat is considered to be negligible.

14.9.14 Overall the cumulative impact as a result of direct habitat loss and physical disturbance is considered to be negligible and therefore the effect is considered to be Not Significant.

Physical Disturbance to Benthic Habitats and Species from Increased Suspended Sediment Concentrations (i.e. Turbidity) and Deposition

14.9.15 Increases in SSC (i.e. turbidity) and the subsequent physical disturbance from increased deposition and turbidity (including the release and re-deposition of sediment-bound contaminants) is predicted to occur for all of the assessed cumulative developments.

14.9.16 Capital dredging in the Tees Estuary would be required as part of the York Potash Harbour Facilities Order (ID 2) and for the Northern Gateway Container Terminal (ID 79). Increases in SSC would also occur during Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4) cable installation activities (cable burial), to the south east of Tees Bay.

14.9.17 Should dredging works occur concurrently within the Proposed Development, there is potential for adverse cumulative impacts to occur. For example, indirect effects from physical disturbance associated with increased SSC, smothering and toxicity from the release of sediment-bound contaminants may occur on benthic ecology and fish and shellfish receptors. Furthermore, direct effects may have a cumulative impact on fish, predominantly migratory species, where the SSC plume may prohibit upstream movement.

14.9.18 However, dredging potentially required as part of the Proposed Development (for the new outfall head) is anticipated in the Tees Bay and will represent a small area, only. Therefore, this activity is unlikely to result in a cumulative increase in SSC in the Tees Estuary. In addition, it is considered unlikely that dredging operations associated with these cumulative developments would

occur concurrently and as such the cumulative impact on marine ecology from increases in SSC is predicted to be negligible and therefore the effect is predicted to be Not Significant.

Changes in Underwater Soundscape

14.9.19 There is a potential pathway for the cumulative increase in underwater sound in the marine environment as a result of the assessed cumulative developments. This is from piling activities and noise from vessels associated with constructions works as part of these developments.

14.9.20 If these activities were to occur concurrently with the Proposed Development, a cumulative increase in underwater sound could result in increased behavioural disturbance effects to some species. For example, the migration of marine mammals and fish and shellfish species in the Tees Estuary could be inhibited. This is particularly true for grey seals and breeding harbour seals which have a haul-out site at Seal Sands, on which potential effects are considered in the impact assessments for the York Potash Harbour Facilities Order (ID 2) and the Northern Gateway Container Terminal (ID 79).

14.9.21 It is unlikely that these activities will occur simultaneously for a continuous period of time, meaning that there would be periods during which unimpeded movement of these receptors would be possible. Furthermore, both the drilling of pin piles and dredging as part of the Proposed Development, are to be undertaken in the Tees Bay, meaning there is not considered to be the potential for these activities to result in a temporary acoustic barrier in the River Tees which would impede migratory fish movements. Consecutive project activities producing underwater sound is possible although should this occur the likely impact zones will not overlap with the Proposed Development.

14.9.22 Given the temporary, short-term and intermittent nature of behavioural disturbance effects as a result of underwater sound from the Proposed Development and the low likelihood that activities from cumulative developments would occur concurrently or consecutively, the potential for cumulative impacts is negligible and therefore the effect is Not Significant.

Loss or restricted access to commercial fishing grounds

14.9.23 There is a potential for a cumulative impact pathway on the loss or restricted access to commercial fishing grounds as a result of the Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4).

14.9.24 It is considered that cumulative effects would only occur for commercial fishing types found in the Tees Bay, where there is a potential for restricted access as a result of the Proposed Development. It is understood that this area is mainly used for potting and trapping by a limited number of smaller vessels (10 m and under) (Smith, pers. comms., 2021). In relation to the Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4), similar commercial fishing would occur inshore to the south east of Tees Bay.

14.9.25 Due to the short duration of the installation of the export cables and pipelines of the Dogger Bank Teesside A / Sofia Offshore Wind Farm (ID 4) development, any restricted access to fishing grounds would be of a temporary nature. Any potential restricted access to commercial fishing grounds as a result of the Proposed Development would also be of a short

duration and representing a very small area. Therefore, even if activities were to occur concurrently, the loss of fishing grounds would negligible and as such so is the potential for cumulative impacts, and therefore the effect is considered to be Not Significant.

Cumulative Effects during the Operational Phase

14.9.26 No potential cumulative impact pathways were identified for the operational phase of the Proposed Development.

Conclusion

14.9.27 No likely significant cumulative effects are identified, given the conclusions presented in the ES for the Proposed Development in isolation, the additional considerations presented above, and the mitigation and enhancement measures outlined in Section 14.7.

14.10 In-combination Assessment

14.10.1 The CO_2 Export Pipeline is to be constructed from the HP Compressor (within the main PCC Site) across Coatham Dunes and Coatham Sands to MLWS. The consenting of the part of the pipeline from MHWS to MLWS is by use of a DML included within the DCO Application, the effects of which have been discussed within this ES Chapter. The CO_2 Export Pipeline will extend beyond MLWS, which will then connect to the offshore storage facility. Consent for this section has not been considered within this Application.

14.10.2 The CO_2 Export Pipeline will be constructed using HDD technologies, avoiding both Coatham Dunes and Coatham Sands (see Chapter 5: Construction Programme and Management, ES Volume I, Document Ref. 6.2, for further details). The preferred methodology is for the HDD to be drilled from approximately 3 km offshore (where there is a minimum of 5 m water depth), outside of the Site boundary, to onshore at the PCC Site. However, the worst-case scenario is for the HDD to be drilled from onshore to offshore. In both scenarios three HDD bores may be required:

- For the CO_2 Export Pipeline itself;
- For the power and fibre-optic control cable umbilical to the offshore installation; and
- For the power and fibre-optic control cable umbilical for the offshore isolation valve.

14.10.3 The Marine Licence application for the offshore section of the CO_2 Export Pipeline will require a separate environmental assessment. However, the combined effects on marine ecology and nature conservation of the continuation of the pipeline from MLWS has been considered within this ES Chapter. For all combined effects associated with the Proposed Development, see Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2) and Appendix 24C: Statement of Combined Effects (ES Volume III, Document Ref. 6.4).

14.10.4 For combined effects associated with the CO_2 Export Pipeline, the following marine ecological impact pathways were identified:

- Direct loss and physical disturbance to habitat and species;
- Physical disturbance to habitats and species from increased SSC (i.e. turbidity) (including deposition of contaminant remobilisation);
- Indirect effects to marine ecology from changes in marine water quality (excluding turbidity) (such as accidental spillages of fuel, and oils); and
- Changes in underwater soundscape.

Direct Loss and Physical Disturbance to Habitat and Species

14.10.5 The construction activities associated with the CO_2 Export Pipeline which have the potential to result in the direct loss and physical disturbance of marine habitats and species include:

- The drilling of the HDD bores in the subtidal, located 3 km offshore, where the HDD will either be drilled offshore, or emerge in the subtidal from onshore drilling;
- The burial of the CO_2 Export Pipeline, from the HDD bore locations to the offshore storage facility;
- The anchoring, grounding or positioning of support vessel(s), and moored lay barge(s); and
- A pre-installed temporary structure standing on the seabed at the HDD bore locations, the purpose of which is to support the drill pipework as it creates and maintains the drill hole through to completion of service installation.

14.10.6 Most of these activities are expected to result in a temporary impact, with recovery following physical disturbance to occur over reasonable timescales. This is with the exception of the HDD bores which would result in the permanent loss of subtidal habitat, although the footprint this would represent is considered to be negligible. The area of temporary and permanent habitat loss as a result of the CO_2 Export Pipeline is yet to be determined. However, a worst-case scenario has been presumed in order to predict the habitat loss within the subtidal zone.

14.10.7 The CO_2 Export Pipeline is to be constructed using trenchless technologies (HDD), meaning there will be no direct loss of intertidal and subtidal habitats and their associated macrofaunal communities from the main PCC Site to the breakout of the HDD Bores, located around 3 km offshore.

Subtidal Habitats and Communities

14.10.8 Based on data collected as part of the Teesside OWF (Entec UK Limited, 2011) (which conforms with the 2019 Teesside Net Zero subtidal benthic ecology surveys, collected further in-shore), the subtidal benthic habitat surrounding the HDD bores is likely to be characterised by the biotope ‘Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’ (EUNIS A5.242) (see Figure 14A-14, ES Volume II, Document Ref. 6.3). This biotope is representative of Annex I habitat and is also afforded national conservation protection. Further offshore, where the CO_2 Export Pipeline is to be buried, the subtidal habitat

continues to be characterised by the biotope 'sublittoral sand' (A5.2), which is also representative of Annex I habitat. This is according to data from the UKSeaMap 2018 broad-scale habitat map[20] (JNCC, 2018).

14.10.9 Soft sediment habitats are known to be highly resilient to direct physical disturbance arising from substrate loss (e.g. dredging) and penetration (e.g. from anchoring or grounding of vessels), according to MarLIN. However, any habitat is regarded as intolerant of permanent loss. Overall, the subtidal benthic ecology surrounding the HDD bores and the pipeline corridor, would have a medium sensitivity to direct los and physical disturbance.

14.10.10 Temporary loss and physical disturbance of subtidal sandflats, representative of Annex I habitats, would occur during the construction of the CO_2 Export Pipeline. The largest area of potential effects would be from under the footprint of the pipeline, from the HDD bore to the offshore storage facility. However, the pipeline is to be buried under the sediment, meaning any habitat loss would be temporary and short-term. Furthermore, any infrastructure used for the HDD drilling, would be removed following the CO_2 Export Pipeline construction. This includes the pre-installed temporary structure standing on the seabed at the HDD bore, or any support vessel(s), and moored lay barge(s) which will be anchored, grounded or positioned. It is anticipated that any habitat lost would recover over reasonable timescales (i.e. <5 years) as the habitats known to be present are well adapted to regular natural disturbance from, for example, storm events.

14.10.11 It is expected that permanent subtidal habitat loss would occur under the footprint of the HDD bores. There will be a total of three bores, each measuring <1 m in diameter. This would represent an area of <2.5 m^2 where a permanent loss of Annex I subtidal sandflat habitat would occur. This permanent loss of habitat is considered to be negligible given the homogenous nature of the subtidal habitat in the area.

14.10.12 Overall, although the construction works associated with the CO_2 Export Pipeline is expected to alter the subtidal habitat under the footprint of the marine works, these adverse effects would be highly localised. Furthermore, the area of permanent habitat loss is very small, with large areas of similar habitat available nearby. In-combination with the effects of direct loss and physical disturbance to subtidal habitats and communities associated with the Proposed Development, the effect of the construction of the CO_2 Export Pipeline is predicted to be Not Significant.

Fish and Shellfish

14.10.13 Fish and shellfish may be affected by the direct loss and physical disturbance of functional habitats (i.e. those used for spawning or as nursery grounds) under the footprint of the temporary or permanent marine construction works, associated with the CO_2 Export Pipeline. Those most at risk include less mobile or benthic life stages (e.g. eggs and larvae) and

[20] The UKSeaMap 2018 is a composite of two broad-scale habitat maps, which have been modelled using seabed substrate input data. These habitat maps are:
- A broad-scale habitat map of roughly 100 m resolution, which covers the majority of the UK shelf area; and
- The EUSeaMap 2016, which is a broad-scale habitat map of coarser resolution, which covers all European seas.

species (e.g. shellfish) potentially vulnerable to mortality and are unable to escape.

14.10.14 The potential area of effects from the CO_2 Export Pipeline, is not considered to provide particularly important functional habitat for most fish and shellfish. This is with the exception of sandeel (*Ammodytes* spp.), which exhibit a degree of site fidelity, meaning they are likely to be more vulnerable to habitat disturbance. There is evidence to suggest that this species uses this area as a nursery ground as outlined in Appendix 14B: Fisheries and Fish Ecology (ES Volume III, Document Ref. 6.4).

14.10.15 Despite this, most species and life stages of fish and shellfish, known to be present in the area, are highly mobile and would be able to move away from the area of disturbance (e.g. around the HDD bore locations). Given the high prevalence of the same or similar habitat, fish and shellfish (including sandeels) would be tolerant of displacement. Furthermore, fish and shellfish would be able to recolonise suitable habitat following the completion of the construction works, meaning recovery of species populations and habitat function following the temporary loss of subtidal habitat (i.e. from the burial of the pipeline) would also be expected. The sensitivity of fish and shellfish to direct loss and physical disturbance as a result of the CO_2 Export Pipeline is considered to be low.

14.10.16 Overall, although there is potential for some direct loss and physical disturbance to fish and shellfish (excluding migratory fish) within the footprint of the CO_2 Export Pipeline marine works, given the localised and temporary nature of the impact, there is unlikely to be any discernible effect to functional habitats or species populations. Furthermore, the area that would be affected is considered to be negligible, meaning that in-combination with the effects of the Proposed Development, the effect of direct loss and physical disturbance to fish and shellfish (excluding migratory fish) as a result of the CO_2 Export Pipeline is predicted to be Not Significant.

Marine Mammals and Designated Sites

14.10.17 Based on the outcome of the assessment of in-combination effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals is predicted to be Not Significant.

Physical Disturbance to Benthic Habitats and Species from Increased Suspended Sediment Concentrations (i.e. Turbidity) and Deposition

14.10.18 The CO_2 Export Pipeline construction activities listed below, have the potential to increase suspended sediment concentrations (SSC) (i.e. turbidity) and create a sediment plume within the marine environment:

- The drilling of the HDD bores in the subtidal, located 3 km offshore, where the HDD will either be drilled offshore, or emerge from onshore drilling;
- The release of WBM used as part of the HDD drilling, either where the HDD is being drilled offshore, or as the HDD emerges into the subtidal (being drilled from the main PCC Site);

- The burial of the CO_2 Export Pipeline, from the HDD bore locations to the offshore storage facility by jetting (as the worst-case scenario);
- The anchoring, grounding or positioning of support vessel(s), and moored lay barge(s); and
- The installation and removal of the temporary structure standing on the seabed at the HDD bore locations, the purpose of which is to support the drill pipework as it creates and maintains the drill hole through to completion of service installation.

14.10.19 An increase in SSC can cause increased deposition as suspended sediments settle out. Both increased turbidity and deposition can cause physical disturbance to benthic habitats and species with potential for indirect effects to higher trophic levels. The release and re-deposition of sediment-bound contaminants also has the potential to effect benthic habitats and species through toxicity.

14.10.20 In general, the release of suspended sediment and subsequent deposition is not expected to significantly alter the geomorphology or structure of substrates such that there is likely to be indirect effects to marine ecology.

14.10.21 In Tees Bay and the surrounding area, information on sediment contaminant sampling is somewhat limited. However, sediment sampling as part of the Teesside OWF (Entec UK Limited, 2004), found that levels of sediment contamination in the wind farm site were below Canadian sediment quality guidelines Probable Effects Levels (PELs) (CCME, 1999). Contaminant levels in the wind farm site were also found to be below those sampled by Cefas in Tees Estuary and Teesmouth area. Despite this, if any contaminated sediments are disturbed during the construction phase, these would be expected to disperse and settle out over a wide area and thus, the potential for impact to marine ecological receptors would be limited.

14.10.22 The overall significance of effects to marine ecological receptors is assessed in the following sections.

Subtidal Habitats and Communities

14.10.23 The subtidal benthic habitat surrounding the CO_2 Export Pipeline, is considered to be characterised by one biotope (EUNIS A5.242), which represent the habitat ‘subtidal sands and gravels’, and qualifies as a habitat of principal importance and as the Annex I habitat ‘sandbanks slightly covered by sea water all the time’ (see paragraph 14.10.8). These subtidal habitats are considered to exhibit low sensitivity (Tilin and Rayment, 2016; Tilin and Garrard, 2019).

14.10.24 The CO_2 Export Pipeline construction activities, such as the creation of HDD bores, may result in the mobilisation of sediment which would increase SSC and turbidity. Considering that the sediment surrounding the footprint of the CO_2 Export Pipeline consists predominantly of sand and gravel, it is expected that any SSC plume would be small and would settle rapidly close to the area of disturbance. In both HDD drilling scenarios, any sediment mobilisation would be temporary and limited to either the start of the HDD drilling (in the preferred drilling scenario) or as the HDD emerges in the subtidal (in the onshore to offshore drilling scenario).

14.10.25 The release of WBM during the drilling of the HDD bores, is expected to create a SSC plume which has the potential occur over larger distances. This is because the WBM material consists of fine particulate matter such as bentonite clays. However, evidence from similar projects indicates that effects on subtidal benthic macrofauna from WBM, is generally restricted to between 100 to 250 m from the source of drilling and recovery is expected to occur rapidly following disturbance (Bakke *et al.,* 2013). Taking this into consideration, as well as the homogenous nature of subtidal benthic habitats and communities in Tees Bay and the surrounding area, any effects from the release of WBM would be highly localised and temporary and would not significantly alter the subtidal benthic community structure of the wider area.

14.10.26 Sediments will be mobilised during burial (e.g. by jetting or ploughing) of the offshore CO_2 Export Pipeline. However, the width of the route is narrow which limits the size of the footprint, and the sandy sediments will rapidly settle back to the seabed resulting in low level localised impacts only.

14.10.27 Overall, given the small special extent and temporary nature of impact on sediment habitats and communities from increased turbidity and deposition (i.e. small in extent, temporary and localised), in-combination effects during the construction of the CO_2 Export Pipeline is predicted to be Not Significant.

Fish and Shellfish

14.10.28 Mobile species or life stages of fish would be expected to move away from unfavourable conditions and would be capable of returning to an area once adverse conditions had abated. Although demersal life stages are less able to adapt to adverse levels of turbidity and deposition, many are known to be reasonably tolerant of smothering (Kiørbe *et al.*, 1981). Overall, the sensitivity of fish and shellfish to increased SSC and deposition is considered to be low.

14.10.29 Any increase in SSC and turbidity as a result of the construction of the CO_2 Export Pipeline, will be localised to the Tees Bay. This area is not considered to provide particularly important functional habitat for most fish and shellfish (with the exception of sandeel which are known to utilise the area as a nursery ground), nor do migratory fish species utilise these areas for any specific purpose. Therefore, given the predicted extent and duration of impacts to turbidity, a plume of sediment is unlikely to present a barrier to migratory fish species or result in the direct disturbance of most other fish and shellfish species.

14.10.30 In the case of demersal species (such as sandeel) and life stages, it is anticipated that water currents would disperse SSC and remove overlying deposited sediments. This means that the risk of displacement and physiological damage or mortality of these species is considered to be low.

14.10.31 Overall, given the low sensitivity of fish and shellfish, and the small special extent and temporary nature of impact, the in-combination effects from an increase in SSC and turbidity on this receptor as a result of the CO_2 Export Pipeline is predicted to be Not Significant.

Marine Mammals and Designated Sites

14.10.32 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish from increased SSC and turbidity during the construction of the CO2 Export Pipeline, any in-combination indirect effect from a loss of food resources to marine mammals including harbour seals (which are a feature of the Teesmouth and Cleveland Coast SSSI) is predicted to be Not Significant.

Indirect Effects to Marine Ecology from Changes in Marine Water Quality (Excluding Turbidity)

14.10.33 Discharges into the marine environment during the construction of the CO_2 Export Pipeline, which has the potential to alter water quality in terms of physio-chemical, biological and chemical parameters with indirect effects to marine ecology, include:

- accidental spillages of fuel, oils and chemicals from support vessel(s), and moored lay barge(s); and
- the release of WBM, used during the drilling of the HDD bores.

14.10.34 As part of the drilling of the HDD bores, WBM are to be used, the proposed materials for which are bentonite and barite. Both bentonite and barite are included on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR, 2019). As such, any release of WBM into the marine environment at each of the HDD bore locations, is not considered to result in changes in marine water quality. Therefore, potential indirect effects to marine ecology have not been considered for this activity.

14.10.35 As part of proposed design and good practice mitigation measures, marine vessels used during the construction of the CO_2 Export Pipeline will comply with regulations relating to the International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78)[21]. This is with the aim of preventing and minimising pollution from ships, meaning the risk of accidental spillages of fuel, oils, and chemicals will be significantly reduced.

14.10.36 Given the highly dynamic nature of the Tees Bay and surrounding area, in the unlikely event that any pollutants or contaminants were discharged, these would be rapidly dispersed and diluted. Furthermore, considering the proposed design and good practice mitigation measures, any indirect effects to marine ecology from changes in marine water quality would be expected to be highly localised, temporary and short-term. Any effects to marine plankton communities (which are known to have a rapid turnover) and subtidal benthic habitats and species (including less mobile life stages of fish, such as demersal eggs and larvae) are predicted to be negligible.

14.10.37 Mobile receptors such as some fish species and life stages (including migratory species) and marine mammals would also be able to move away

[21] http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

from adverse water quality conditions and so effects to these receptors would be limited.

14.10.38 Considering the low risk and nature of the impact, it is unlikely that there would be any discernible effect to the abundance, distribution or functioning of habitats and species populations beyond the local level. Thus, the in-combination indirect effects to marine ecology receptors from changes in marine water quality (excluding turbidity) during construction of the CO_2 Export Pipeline are predicted to be Not Significant.

Changes in Underwater Sound

14.10.39 During the construction of the CO_2 Export Pipeline, the drilling of the HDD bores will create underwater sound and vibration within the marine environment. This sound source is considered to be non-impulsive (i.e. continuous) and has the potential to result in physiological and behavioural effects to the marine receptors: fish and shellfish; and marine mammals and designated sites.

14.10.40 Similar to the boring of the MBT (as part of the replacement outfall), the HDD bores will be drilled 10 m below the seabed, meaning that underwater sound effects are only expected at the start of the drilling in the preferred scenario (i.e. the HDD is to be drilled from approximately 3 km offshore). For the worst-case scenario, where the HDD is to be drilled from onshore to offshore, underwater sound effects will occur as the HDD emerges in the subtidal. This means that for the HDD bores, the source of sound will be very short-term and temporary. Furthermore, as the HDD drilling will be in soft sediment, the sound source levels as a result of this activity are expected to be low compared to other construction activities associated with the Proposed Development (such as the drilling of pin piles).

14.10.41 For fish and shellfish, the effects of underwater sound have been discussed in paragraphs 14.6.80, onwards. Based on the sensitivity thresholds published by Popper *et al.* (2014) for non-impulsive sound sources (outlined in Table 14-9), the potential for mortality or mortal injury, even in high sensitivity fish, is considered to be low even in the near-field (i.e. tens of metres from the sound source). However, there is a high and moderate risk of behavioural disturbance within the near- and intermediate-field (i.e. hundreds of metres from the sound source). Despite this, high hearing sensitivity fish are generally pelagic species, which are highly mobile and free-ranging. This means that for the drilling of the HDD bores, it is unlikely that these individuals will remain within the impact zone, and would be unlikely to sustain injurious impacts. Furthermore, given the short-term and temporary nature of effects, behavioural disturbance to fish as a result of the drilling, is also thought to be negligible.

14.10.42 For marine mammals, underwater sound can result in physical harm to individuals, or behavioural responses such as alteration of movement or diving behaviour (see paragraphs 14.6.100, onwards for detailed discussion on effects of underwater noise on marine mammals). In general, most marine mammals are highly mobile, and would be expected to move away from any sources of underwater noise disturbance, meaning the potential for PTS as a result of the drilling of the HDD bores is considered to be low. However, TTS

and behavioural disturbance is likely to occur for individuals close to the sound source. Despite this, it is anticipated that any effects will be limited to the HDD bore location only (approximately 3 km offshore) where drilling will be for a short and limited period of time. In addition, although cetaceans, such as harbour porpoise, are known to visit the Tees Bay, the abundance of these species are expected to be low. This is also true for pinnipeds, given the potential distance of the HDD bores from the seal colony at Seal Sands. As such, there is considered to be limited potential for detectable changes in the abundance, distribution and conservation status of marine mammals as a result of the drilling of the HDD bores.

14.10.43 Considering the short-term and temporary nature of the impact, the in-combination effects to marine ecology receptors from changes in underwater sound during construction of the CO_2 Export Pipeline are predicted to be Not Significant.

14.11 Residual Effects and Conclusions

14.11.1 Having taken into account the design, good practice mitigation and additional information described in the preceding sections, this ES chapter has concluded no significant adverse effects to marine ecology from construction, operation (including maintenance) or decommissioning of the Proposed Development.

14.12 References

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