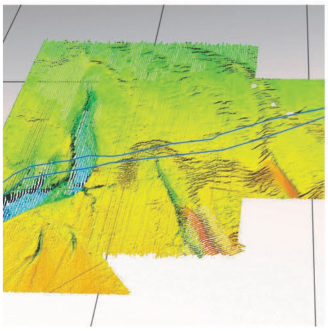
Breedon Group

Bedwyn Sands and North Middle Ground Environmental Statement

Aggregate Dredging Licence Renewal

November 2023



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Non-Technical Summary

This Non-Technical Summary (NTS) provides a concise description of the Environmental Statement (ES) that supports Breedon Group's applications for permission to dredge marine sand from Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) in the Severn Estuary (Figure NTS.1). The NTS follows the same structure as the ES, providing a summary of each section. The full results of the comprehensive investigations that have been undertaken, together with the analyses and conclusions that have been used to underpin the environmental assessment of these proposals, can be found in the main ES.

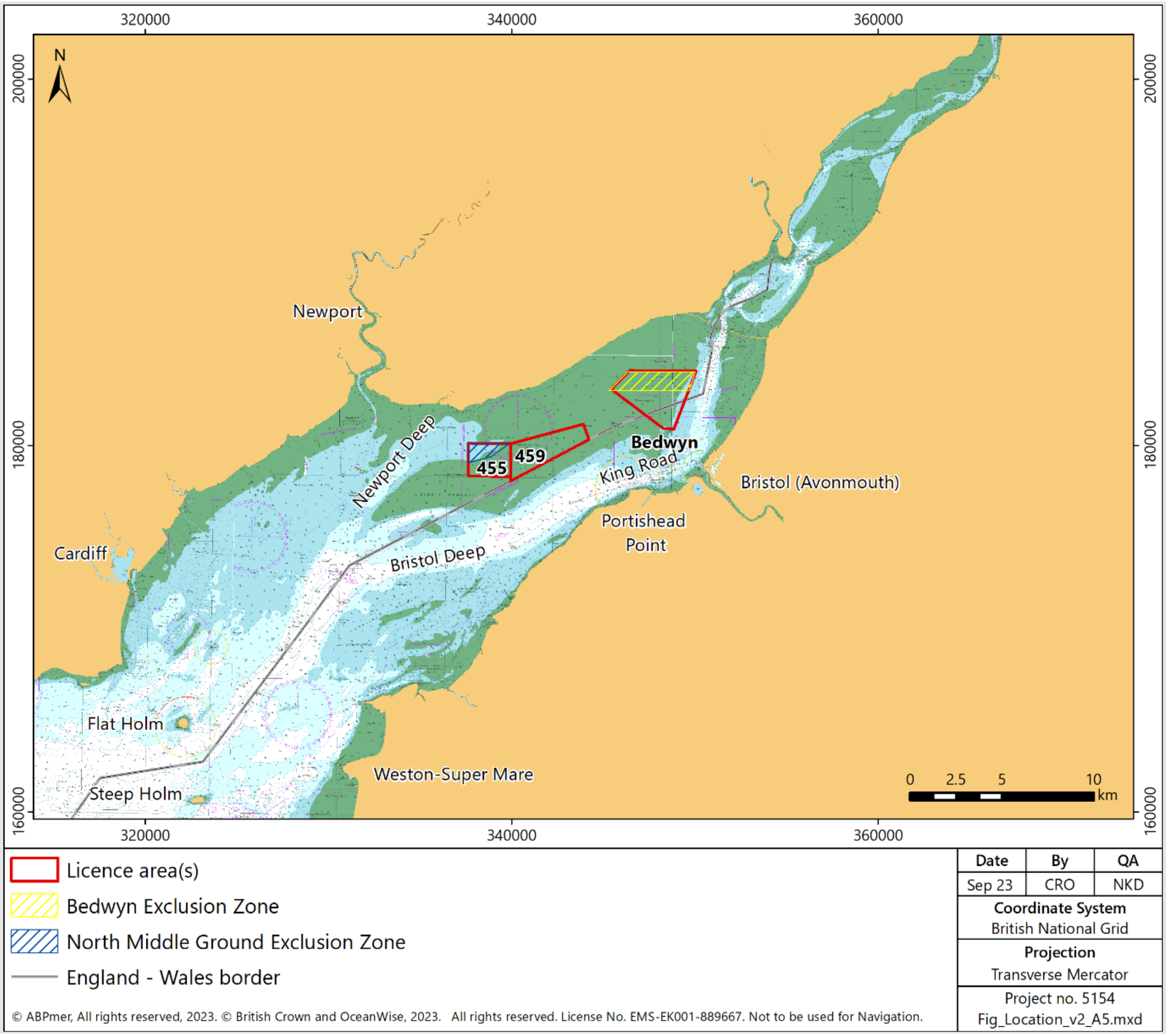

Figure NTS.1 Location of Bedwyn Sands and NMG (Areas 455 and 459) licensed aggregate sites (Renewal Areas)

Project Summary (Section 1)

Breedon Group wishes to apply for permissions to dredge marine aggregate from Bedwyn Sands and NMG. The Welsh/English border runs through the southern part of Bedwyn Sands and NMG is located entirely within Welsh waters (Figure NTS.1). Marine licences must be granted before aggregate extraction can commence. These will need to be obtained from the English authority (the Marine Management Organisation (MMO)) and the Welsh authority (Natural Resources Wales (NRW)). To simplify the application process, the Bedwyn Sands area has been split into English and Welsh sub-areas. The ES considers both sub-areas and will be used to apply for both the English and Welsh marine licences.

Bedwyn Sands covers an area just less than 9.4 km^2 and NMG (Areas 455 and 459) covers a combined area of approximately 10.4 km^2. An annual maximum offtake tonnage of 250,000 tonnes is proposed for Bedwyn Sands (with no more than 150,000 from Welsh waters) and an annual maximum tonnage of 250,000 tonnes is proposed for NMG (i.e. total 500,000 tonnes). This represents no change compared to the current permitted offtake for these Areas.

The ES has been prepared to support the marine licence applications, which documents all the relevant Environmental Impact Assessment (EIA) information. During the scoping phase of the EIA, consultation was undertaken with the MMO and NRW. A consultation log is provided in Appendix A of the main ES.

Project Need and Alternatives (Section 2)

Background

Marine aggregates play a key role in servicing the nation's demand for construction aggregate and supplying materials for the maintenance of coastal and flood protection defences required for climate change adaptation. Marine aggregates also contribute to energy security and economic development through provision of fill for major coastal infrastructure projects, for example ports, renewable energy and nuclear energy projects.

South East Wales has a high current and historic dependence on marine aggregates, and the aggregate dredged from the Severn Estuary and Bristol Channel is considered to be of high quality with virtually no outsize wastage and significant manufacturing and production benefits.

Breedon Group is applying for permission(s) to continue to undertake aggregate extraction at the Bedwyn Sands and NMG Renewal Areas.

Consideration of alternatives

Two alternative options to dredging marine aggregates from Bedwyn Sands and NMG have been considered within the ES. These were a "do nothing" option, which involved not submitting the licence applications, and an "alternative source of aggregate" option that involved winning aggregates from elsewhere. Both options were dismissed as inferior alternatives to extracting aggregate from Bedwyn Sands and NMG, due to the demand for marine aggregate in the region and the economic and environmental implications of sourcing aggregate from elsewhere. The deposits within Bedwyn Sands and NMG are proven, viable resources and the effects of extraction are well understood.

Project Description and Methodology (Section 3)

Breedon Group is seeking licences to extract up to a maximum of 3,750,000 tonnes at Bedwyn Sands and the same amount at NMG over 15 years, at a maximum rate of 250,000 tonnes per annum in each area. The location of Bedwyn Sands and NMG, relative to the England – Wales border is shown in Figure NTS.1.

On average, there are expected to be between 0.6 and 3 cargoes per week from each Renewal Area. At maximum annual extraction rates, there is estimated to be 4.4 cargoes per week from each Area. A trailer suction hopper dredger (TSHD) with a capacity of 1,100 tonnes will continue to be used to extract sand aggregates from Bedwyn Sands or NMG.

Breedon Group is seeking consent to undertake TSHD and screening activities on Bedwyn Sands and NMG. The licences are to also include the permission to take core and grab samples from the seabed in, and potentially around, Bedwyn Sands and NMG for resource management and monitoring purposes.

TSHD is a common method used in the marine aggregate industry and involves trailing specialised pipes along the seabed that pump aggregate up into the vessels hopper. Unwanted aggregate, typically of the wrong size, may be sorted or "screened" by the dredger and ejected back into the water column. These discharges will take place within the active dredge zone and will consist of sand and gravel with a very small proportion of fine material.

In order to reduce the environmental impacts dredging has on the seabed, Breedon Group will observe standard industry mitigation measures (i.e. measures to reduce impacts). Breedon Group will thus not extract all the aggregate from the area, will leave a capping layer of at least 0.5 m and will also leave the seabed sediment in a similar condition to when dredging began. Regular operational monitoring will also be undertaken. In addition to this, there will likely be zoning within Bedwyn Sands and NMG, which means that dredging will not occur across the whole area all the time, leaving marine life in some areas unaffected and therefore allowing it to move into the dredged areas once dredging activity has stopped.

Impact Assessment Approach (Section 4)

This section describes the methods used to assess the potential impacts aggregate extraction from Bedwyn Sands and NMG may have on the marine environment. To undertake such an 'Environmental Impact Assessment' (EIA), advice has been provided by regulators and stakeholders. A large amount of information has also been gained from published sources and analysis has been undertaken to help describe the current environmental conditions in the region and inform the assessment.

The EIA has been undertaken by ABPmer, with support from Wessex Archaeology. Both companies operate accredited quality management systems and have extensive experience and technical competency in their respective fields. ABPmer has furthermore been awarded an EIA Quality Mark by the Institute of Environmental Management and Assessment (IEMA) for its service excellence in the co-ordination of EIAs and the production of ESs.

Study area and impact zone definitions

For this EIA, the immediate 'study area' is defined as the area over which potential direct and indirect impacts of dredging in Bedwyn Sands and NMG are predicted to occur. This is split into two impact zones, namely:

i. The Primary Impact Zone (PIZ) refers to the maximum future footprint (i.e. the area where dredging is predicted to occur over the course of the licence). Note: This category includes the effects associated with the passage of the draghead over the seabed including sediment removal.

ii. The Secondary Impact Zone (SIZ) refers to the local zone(s) where effects that extend beyond the immediate footprint of dredging occur. This is usually associated with the areas where any fine-grained sediment that may be entrained within a dredge plume settles back to the seabed, as well as the areas over which screened sediment may disperse and thus change the seabed or sediment characteristics. For aggregate dredging in the Severn Estuary/Bristol Channel, a maximum secondary impact zone of 500 m has been applied. This is considered scientifically justifiable due to the high tidal flows and natural turbidity observed in the Severn Estuary/Bristol Channel region.

For most topics, a 'wider study area' has also been adopted to facilitate further characterisation; for this EIA, this comprises the Severn Estuary. For marine mammal receptors, a larger study area encompassing the Bristol Channel was applied due to their highly mobile nature.

Impact assessment scope

The assessment considers the potential effects on the following environmental topics (receptors):

- Physical Processes;
- Water and Sediment Quality;
- Nature Conservation;
- Benthic Ecology;
- Fish and Shellfish Ecology;
- Marine and Coastal Ornithology;
- Marine Mammals;
- Commercial and Recreational Fisheries;
- Commercial and Recreational Navigation;
- Marine Archaeology;
- Coast Protection and Flood Defence;
- Air Quality;
- Infrastructure and Other Marine Users;
- Human Health; and
- In-combination/ Cumulative Effects.

Environmental topics not considered to have the potential to be affected by dredging activity on Bedwyn Sands and NMG and therefore not considered in the assessment are:

- Airborne Noise and Vibration;
- Landscape/Seascape and Visual;
- Light; and
- Terrestrial Ecology.

Please note that transboundary effects are not considered likely due to the predicted localised effects of the dredging activity and the large distance between the study area and the nearest non-UK country.

Impact assessment methodology

To facilitate the impact assessment process, a standard analysis methodology has been applied. For each environmental topic this involved describing the current conditions (baseline), identifying all the potential pathways in which an impact could occur, assessing the significance of the potential impact and identifying ways in which any adverse effects can be reduced.

The significance of each potential impact has been assessed using a standard approach. The four key significance levels for either beneficial or adverse impacts are described as follows:

1. **Insignificant**: Insignificant change not having a discernible effect;
2. **Minor**: Effects tending to be discernible but tolerable;
3. **Moderate**: Where these changes are adverse, they may require mitigation (i.e. action to minimise and / or avoid an impact); and
4. **Major**: Effects are highest in magnitude and reflect the high vulnerability and importance of a receptor. Where these changes are adverse, they will require mitigation.

A detailed impact assessment guidance is provided in the full ES.

Impact Assessment

The following sections summarise the findings of the impact assessment for each topic assessed.

Physical Processes (Section 5)

The impact assessment considered physical processes to include coastal characterisation, geology and bathymetry, hydrodynamic/tidal regime and sediment regime. The main data sources used to characterise the baseline conditions of the study area included the outputs of numerical models, bathymetric data and surveys, hydrographic data sources and long-term wind statistics. These were supported by several regional studies encompassing areas within the Severn Estuary.

The assessment considered five pathways, which addressed: the potential for changes in wave energy and tidal currents, changes in sediment movements, changes to seabed morphology, cumulative effects with ongoing dredging and cumulative effects on the coast. All potential impacts on Physical Processes receptors as a result of the proposed dredging in Bedwyn Sands and NMG were **insignificant (not significant)** due to the negligible probability of occurrence and negligible magnitude of change for all physical process impact pathways. No mitigation measures have therefore been proposed, noting that standard industry mitigation measures will be observed.

Water and Sediment Quality (Section 6)

In the ES, water quality parameters considered covered temperature and salinity, dissolved oxygen, suspended sediment, nutrients, bathing waters, trace metals, trace organics and radioactivity, while sediment quality covered metal, polyaromatic hydrocarbons and polychlorinated biphenyls concentrations. A desk study characterised the baseline conditions of the study area, using data from the Environment Agency and NRW. These data were supported by other sources, including Severn Tidal Power's Strategic Environmental Assessment and Charting Progress 2.

The assessment considered four impact pathways; including potential changes to suspended sediment concentrations, dissolved oxygen concentrations, water borne contaminant concentration and redistribution of sediment bound contaminants. All potential impacts on Water and Sediment Quality receptors were assessed as **insignificant (not significant)**, due to the low magnitude of change and low probability of occurrence based principally on the sediment composition of the area. No mitigation measures have therefore been proposed.

A Water Framework Directive (WFD) compliance assessment was also carried out. This is included in Appendix D of the full ES and relates to targets for the improvement of national water quality conditions, specifically for the 'Severn Lower' transitional water body. The conclusion of this assessment suggests that the proposed dredging activity will not lead to a deterioration in water body status, nor prevent this water body from achieving its WFD objectives.

Nature Conservation and Ecology (Section7)

Three international nature conservation designations are located within the study area, namely the Severn Estuary Special Area of Conservation (SAC), Severn Estuary Special Protection Area (SPA) and Severn Estuary Ramsar site. Bedwyn Sands and NMG directly overlap these sites, as well as the Severn Estuary Site of Special Scientific Interest (SSSI). Migratory fish species of the River Usk and River Wye SACs could also be affected by the proposed dredging activities when on migration to and from the rivers.

There are records of protected species and habitats within the study area, including grey seal, common seal, bottlenose dolphin and harbour porpoise; however, marine mammal sightings are not considered a common occurrence at Bedwyn Sands and NMG or throughout the wider study area.

No impact pathways relating to nature conservation have been assessed under this heading, as all features for which sites have been designated are addressed in the relevant receptor sections. A Habitats Regulations Assessment (HRA) in the form of a Signposting Document to facilitate the preparation of an Appropriate Assessment (AA) has been produced and can be found in Appendix C of the full ES. The HRA concluded that dredging within Bedwyn Sands and NMG will not affect the integrity of any of the European/Ramsar Sites, as no failure of the conservation objectives (alone or in-combination) is predicted.

Benthic (Sea-bottom) Habitats and Species (Section 8)

The term benthos is used to define the biological communities living on or in the seabed. A desk-based study was carried out to support the survey data, providing information about the benthic environment at Bedwyn Sands and NMG, as well as at a regional scale within the Inner Bristol Channel and Severn Estuary. The benthic community within Bedwyn Sands and NMG is typical of outer Severn Estuary, composed mainly of sands inhabited by few organisms.

Bedwyn Sands and NMG overlap with the Severn Estuary SAC, and the designated sandbank feature. Comparatively low numbers of individuals of the internationally protected biogenic (*Sabellaria*) have been recorded within the PIZ.

The assessment considered six impact pathways that address: the direct removal of the seabed, increases in suspended sediment, smothering, bathymetric changes, noise, and the introduction or spread of non-native species. The assessment considered the overall potential impacts on the benthic environment to be **minor adverse (not significant)** at worst, due to a species poor benthic community and the localised, relatively small scale, changes predicted to occur as part of the dredging, in the context of the natural variability of the estuary. Specific consideration of *Sabellaria* reef indicates that it is unlikely to be found in areas preferentially selected for aggregate dredging, due to the inappropriate nature of the seabed composition for *Sabellaria* colonisation.

With regard to mitigation measures, the assessment is based on the assumption that Breedon Group continues to observe established marine aggregate industry mitigation measures with regard to benthic receptors (leaving a capping layer and similar sediment; regular monitoring), and that the available biosecurity guidance is followed in due course.

Fish and Shellfish Ecology (Section 9)

The fish and shellfish ecology assessment was informed by various sources, including a desk-based review of surveys that have been undertaken at Bedwyn Sands and NMG, and ongoing annual WFD fish monitoring by NRW and the Environmental Agency. A number of other sources were used to characterise the fish and shellfish present in the region, including monitoring from Hinkley Point, a Severn Estuary fish review and regional spawning/nursery ground information.

Bedwyn Sands and NMG provides habitat for a variety of fish and shellfish species, although diversity and biomass may be relatively low. There are also a number of migratory fish species that are qualifying features of the Severn Estuary SAC, River Usk SAC and River Wye SAC (river lamprey, sea lamprey, twaite shad, allis shad and Atlantic salmon). As migratory species, it is likely that they will move past the Areas at some point throughout the year.

The potential pathways assessed involved: the direct removal of seabed, changes to water quality, and increased levels of noise, vibration and lighting. The effects of dredging in Bedwyn Sands and NMG on sandeel and herring were also assessed separately. Overall, impacts are assessed as **minor adverse (not significant)** at worst, chiefly due to the limited number of species present in Bedwyn Sands and NMG and their ability to move away from the small-scale localised changes predicted to occur as a result of dredging. No mitigation measures specific to fish and shellfish have been proposed (beyond established mitigating practices noted in the benthic section above).

Marine and Coastal Ornithology (Section 10)

The ornithological impact assessment was based upon information gained via a desk study. Data and reports from several sources were consulted, including the Severn Estuary British Trust of Ornithology (BTO) Wetland Bird Survey (WeBS) core and low tide counts, European Seabirds at Sea database, foraging range data and South West Strategic Area aerial surveys.

Bedwyn Sands and NMG overlap the Severn Estuary SPA and Ramsar sites. The assessment therefore considered waterbird species, as well as other marine bird species in the area. Very low numbers of marine birds generally use the Inner Bristol Channel and Severn Estuary, with the exception of gull species.

Potential impacts assessed include: indirect effects of seabed removal, effects on foraging due to suspended sediments, and effects from vessel disturbance. Due to the negligible to low exposure of birds to the potential impacts, the overall effects on ornithology features are assessed as **insignificant**. No mitigation measures specific to bird receptors have therefore been proposed.

Marine Mammals and Turtles (Section 11)

The assessment of impacts on marine mammals and turtles was informed by a desk study that gathered information from several sources, including Management Units for Marine Mammals in UK waters, The Atlas of the Marine Mammals of Wales, Common and Grey Seal Movements at Sea data, and sightings data from the region.

The desk study indicated that harbour porpoise and grey seal were the only commonly occurring marine mammals likely to be present in or around Bedwyn Sands and NMG and were therefore the only marine mammal receptors assessed. Turtle species were not assessed as their presence in the Inner Bristol Channel is considered rare.

Four potential impacts to marine mammals were identified and assessed, these involved: the direct removal of seabed, reduced water clarity, noise and vibration, and collision with dredging vessels. Due to the predicted small scale of the change resulting from dredging activity in Bedwyn Sands and NMG, all impacts were assessed as **insignificant**. No specific mitigation for marine mammals and turtles has therefore been proposed.

Commercial and Recreational Fisheries (Section 12)

The current level of commercial fishing activity occurring within and around Bedwyn Sands and NMG is quite low.

This was determined using a wide range of desk-based data sources. These include regional fishing activity information from the Welsh Government and the Devon and Severn Inshore Fisheries Conservation Authority (IFCA), as well as sighting and landings data from the MMO. Consultation with the Welsh Government, Devon and Severn IFCA, the Welsh Fishermen's Association, the North Devon Fishermen's Association, and charter fishermen who frequent (or might frequent) Bedwyn Sands and NMG was also undertaken to further support the desk study.

The assessment considered three potential impacts which involved: the disruption of fishing activities, the damage of fishing gear and impacts upon fish stocks. All impacts were assessed as **insignificant (not significant)** due to the low level of fishing activity that occurs within and around Bedwyn Sands and NMG. No specific mitigation for commercial fishing has therefore been proposed.

Commercial and Recreational Navigation (Section 13)

The Bristol Channel and Severn Estuary is an important shipping area, with large ships from national and international destinations using the estuary's ports and anchorages.

To characterise the intensity of commercial and recreational navigation in and around Bedwyn Sands and NMG, a desk-based study was undertaken. The key sources of data used included satellite tracking data, as well as callout and accident data from the Marine Accident Investigation Branch (MAIB) and the Royal National Lifeboat Institute (RNLI). Consultation with harbour authorities, the Royal Yachting Association (RYA), the MAIB and the RNLI was also undertaken.

The assessment considered four potential impact pathways, which included: the potential for accidents or incidents arising from the presence of dredging vessels either on transit or within Bedwyn Sands and NMG, the displacement of vessels out of the licence areas, and potential water quality impacts from pollutants resulting from accidents, incidents or spillages. Several mitigation measures aimed at increasing the navigation safety of the Inner Bristol Channel and Severn Estuary currently exist. These include emergency response infrastructure and the application of several pieces of maritime legislation that state best practice methods for safe operations at sea. The aggregate industry has furthermore developed a related code of practice, in consultation with regulators. With these in place, all residual impacts/risks were assessed as potentially **minor adverse (not significant)**; and therefore no further mitigation is considered necessary.

Marine Archaeology (Section 14)

For this assessment, the marine archaeological receptors considered were seabed prehistory and seabed features, including maritime sites, aviation sites and any associated material. A desk-based assessment (DBA) was undertaken by Wessex Archaeology to support this assessment (this can be found in Appendix E of the full ES). The assessment drew on generally consulted sources, as well as a review of available geotechnical and geophysical data (i.e. sediment cores and sonar-derived images of the seabed) and historic records, including UK Hydrographic Office (UKHO), National Monuments Record of Wales and the National Heritage List for England.

The assessment considered two potential impacts, which involved direct and indirect damage to the marine archaeological resource. It was found that, without mitigation, direct impacts could result in potential major adverse effects. The significance of indirect impacts to archaeological receptors was expected to be insignificant. In order to reduce direct impacts to acceptable (minor adverse residual) levels, several mitigation measures were proposed, including future monitoring assessments (and implementation of exclusion zones if considered necessary), and adherence to the existing 'Marine Aggregates Industry Protocol for Reporting Finds of Archaeological Interest'. Based on the proposed mitigation measures, it is considered that the residual overall impact on marine archaeological receptors can be reduced to **minor adverse (not significant)** at worst.

Coastal Protection and Flood Defence (Section 15)

The impact assessment for coastal protection and flood defence was informed by a desk study that reviewed national and regional measures set out in the National Flood and Coastal Erosion Risk Management Strategies for England and Wales, the Flood Risk Management Plan for the Severn River Basin District, and the Severn Estuary Shoreline Management Plan. The desk study also reviewed information regarding the potential impact of future sea level rise on coastal protection and flood defences.

The assessment considered the removal of aggregate from Bedwyn Sands and NMG in relation to its potential to affect seabed height, potentially resulting in a change in wave exposure at the coast, which could in turn affect coastal protection/flood defence. The other impact pathway which was assessed related to the potential for maintaining source aggregate for future coastal defence and beach nourishment projects. The assessment concluded that dredging activities in Bedwyn Sands and NMG will have an **insignificant (not significant)** impact on the coast (in relation to changes in wave height and tidal currents as well as beach draw down) but provide a sustainable source of aggregate for coastal defence works (including nourishment); which is considered **minor beneficial (not significant)** at best.

Air Quality (Section 16)

The assessment of impacts to air quality was undertaken using a desk-based study of regional air quality, as no data specific to Bedwyn Sands and NMG was available. Air quality in the vicinity of Bedwyn Sands and NMG was assessed using information provided by Air quality review and assessment reports from local authorities and Air Quality Management Area websites. To further support the assessment, statistics published by the British Marine Aggregate Producers Association (BMAPA) detailing emissions resulting from aggregate production were also used, although in line with the precautionary principle, emissions statistics were derived from worst case scenarios published by the Crown Estate.

The assessment considered one potential impact pathway for air quality related to the vessel presence, namely the potential for marine aggregate dredger emissions to affect air quality receptors. It is considered that, whilst increased vessel presence has the potential to impact upon air quality, given the low estimated amount of cumulative emissions, impacts are **insignificant (not significant)**. No mitigation specific to air quality is therefore proposed.

Infrastructure and Other Existing Marine Users (Section 17)

A desk study was undertaken in order to identify marine infrastructure and other marine users which may be affected by dredging on Bedwyn Sands and NMG, largely drawing on mapped information.

This indicated that there are no subsea cables, offshore wind farms or oil and gas infrastructure present in or near to Bedwyn Sands and NMG. Dredge disposal sites, other licensed aggregate areas, a Ministry of Defence firing range and several tourist-related activities have, however, been identified in the Inner Bristol Channel and Severn Estuary near Bedwyn Sands and NMG.

The assessment considered one potential impact pathway for this receptor, related to the potential for changes to physical processes occurring (i.e. currents, waves and tides; seabed), thus impacting marine and land-based infrastructure and other marine users. This impact is assessed as **insignificant (not significant)** on the basis that no impacts on the coast have been predicted by the coastal processes assessment (see Section 5). In addition, the proposed activity is currently ongoing and activity levels are not predicted to increase, and marine and coastal infrastructure are sufficiently distant to not be affected. No specific mitigation is therefore proposed.

Human Health (Section 18)

The human health baseline was informed mainly by data from the 2021 and 2011 censuses which provided an insight into the health of the population in the vicinity of Bedwyn Sands and NMG. The Health and Wellbeing Strategy covering the area of coast adjacent to the Inner Bristol Channel and the Well Being of Future Generations (Wales) Act 2015 also supported the baseline.

The assessment considered noise and increased emissions from the proposed dredging activity as having the potential to impact on human health. However, this impact is assessed as **insignificant (not significant)**, largely due to the substantial distance between Bedwyn Sands and NMG and the nearest human dwellings. No mitigation specific to human health is therefore proposed.

Cumulative and In-combination Effects (Section 19)

The impact assessment identified the following relevant plans and projects as having the potential to occur at the same time as dredging in Bedwyn Sands and NMG:

- Aggregate extraction from other Licence Areas in the Severn Estuary and Bristol Channel;
- Bristol Deep Sea Container Terminal;
- Hinkley Point C construction and Point B decommissioning;
- Steart Managed Realignment;
- Severn Flood Risk Management Plan;
- The Avonmouth Severnside Enterprise Area (ASEA) Flood Defence Project; and
- Cardiff Coastal Defence Scheme.

Activities also considered include fishing, shipping, navigation, recreation and disposal sites.

All of these activities, plans and project have the potential to result in impacts that could act in combination with impacts from the proposed dredging on Bedwyn Sands and NMG, the resulting impact of which may be larger than that predicted for either activity.

Overall, whilst uncertainty exists with regard to the cumulative/in-combination effects of some of the plans/projects that are yet to be approved, it is considered that the continued aggregate extraction at Bedwyn Sands and NMG will not substantially change the current baseline, and the cumulative/in combination effects are very small in relation to the wider study area, especially when considered against the scale of other activities and plans. The occurrence of significant adverse cumulative/in-combination effects is therefore considered unlikely.

Mitigation and Monitoring (Section 20)

Various measures have been considered as part of this proposal to minimise the potential impacts of dredging in Bedwyn Sands and NMG on different receiving environments. These include:

- Following the various protocols which have been developed by the British Marine Aggregate Producers Association (BMAPA) in collaboration with other bodies, including for archaeology, navigation and fisheries;
- Undertaking detailed surveys before dredging commences to fill certain gaps, and also regular operational monitoring; and
- Establishing exclusion zones where necessary (e.g. where the resource is less than a 0.5 m thick, or where wrecks or protected reefs are found), and only dredging in 'active dredge areas'.

A pre-dredge and operational monitoring programme is expected to be written into the licence conditions, following common industry practice and up-to-date requirements from the regulators and their advisors.

Conclusions (Section 21)

Best practice procedures and mitigation measures already undertaken by Breedon Group and the wider marine aggregates industry will be applied to contribute to avoiding and/or minimising environmental impacts where possible. Consultation with key stakeholders has been undertaken prior to, and throughout, the assessment to agree environmental issues. This was valuable for confirming that the scheme will have the lowest environmental impact of any available alternative.

The majority of impacts identified in this ES have been assessed to be insignificant or minor adverse (not significant). Where the potential for significant impacts has been identified, the proposed mitigation measures (see Section 20) are considered sufficient to reduce the residual impact significance to minor adverse at worst.

Contents

Appendices

Tables

Figures

1 Project Summary

In this section, a brief project background is provided in Section 1.1, the legislative basis is outlined in Section 1.2, and the report structure is detailed in Section 1.3.

1.1 Project background

Breedon Group wishes to renew permissions to dredge aggregates from Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) in the Severn Estuary, with proposed licence periods of 15 years. Severn Sands Holdings Limited, who was acquired by the Breedon Group in 2022, has been carrying out licensed aggregate extraction activities from Bedwyn Sands and NMG since 2008 and 2011, respectively. The marine licences for both sites were renewed for a further seven-year period in 2017 and are due to expire in 2024.

The two Licence Renewal Areas (NMG and Bedwyn Sands, shown in Figure 1-1) have been grouped together within this Environmental Statement (ES) primarily due to their geographic proximity to each other and, therefore, similarity in terms of environmental issues. Breedon Group is, however, seeking to renew the existing respective Welsh and English licences from the relevant licensing bodies, Natural Resources Wales (NRW) and the Marine Management Organisation (MMO).

The extraction sites are located in the Severn Estuary, within the wider Middle and Welsh Grounds area, which form part of a regional system of intertidal sand flats and banks.

The Bedwyn Sands Production Area is located in the Upper Severn Estuary (Figure 1-1), as the eastward extension of the wider Welsh Grounds area. The resource lies wholly within the marine ownership of the Swangrove Estate and spans the harbour limits of the Gloucester Harbour Trustees (GHT) and the Bristol Port Company (BPC). The Licence Area covers an area just less than 9.4 km^2 and straddles the boundary between English and Welsh territorial waters. Bedwyn Sands is an intertidal 'sand flat' rather than a classic 'sand bank', as it lacks a distinctive crest. It is composed of sediments which range from sand to pebble-sized material, which are sorted as a result of tidal flows over the area. It is the well-sorted medium sand that is of particular interest to the aggregate industry.

The NMG Area (licensed aggregate extraction Areas 455 and 459) is located within the Upper Severn Estuary, between the wider intertidal sandbanks and flats of the Middle and Welsh Grounds (Figure 1-1). The site covers a combined area of approximately 10.4 km^2, off the Welsh coastline and is entirely within Welsh territorial waters. The morphology of the NMG is characterised by sandwave and ripple features. As with Bedwyn Sands, the NMG Area is composed of a range of sand to pebble-sized sediment, which are sorted by the strong tidal flows within the region. It is the medium to coarse sand that is of particular interest to the aggregate industry.

The renewal applications will seek to continue aggregate dredging, from each of the sites, at the same maximum annual extraction rates as are presently licensed (see Table 1-1).

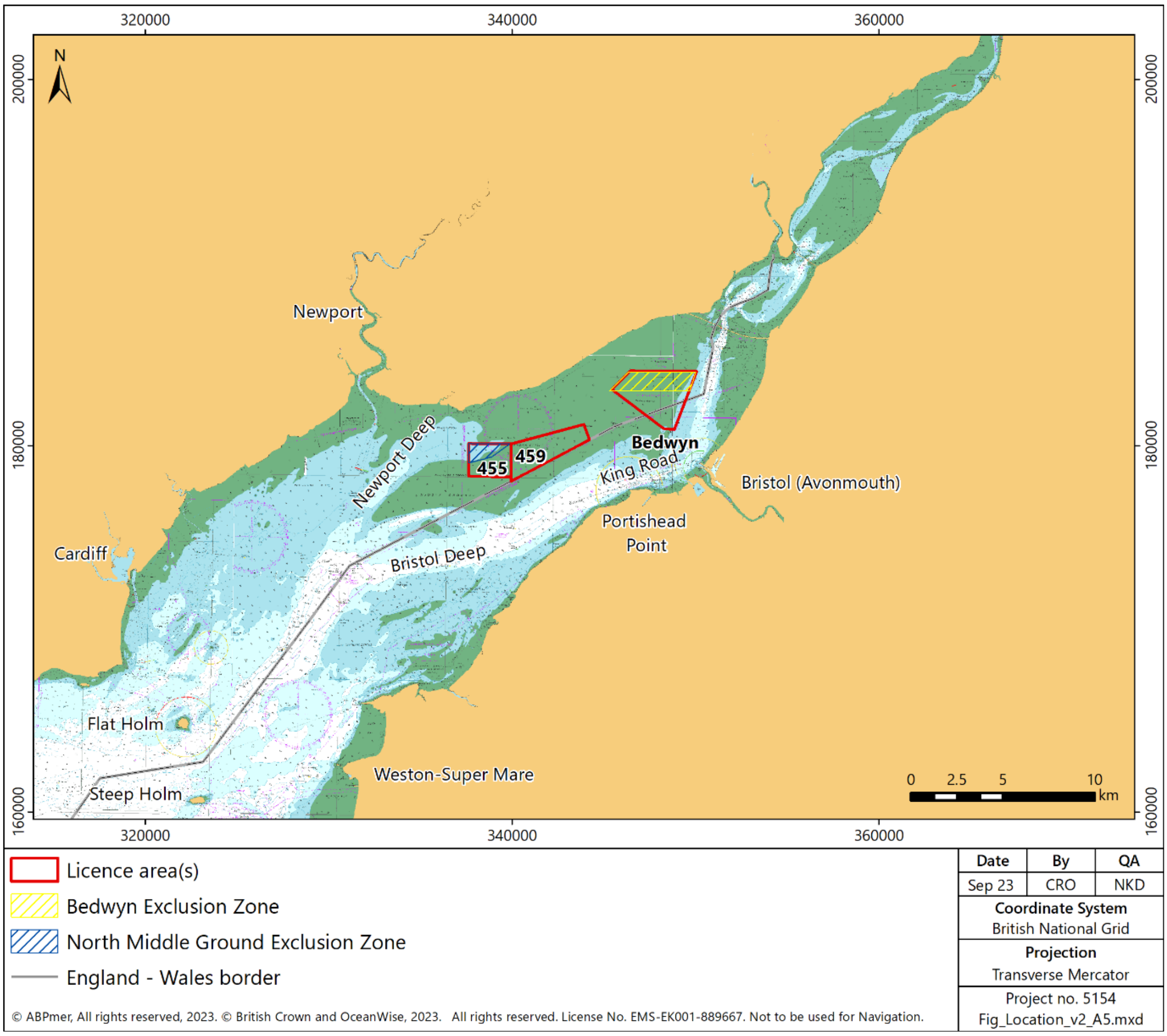

Figure 1-1 Location of Bedwyn Sands and NMG (Areas 455 and 459) licensed aggregate sites (Renewal Areas)

Table 1-1 Proposed licence conditions for the Licence Renewal Areas

Parameter	Bedwyn Sands	North Middle Ground (Areas 455 and 459)
Licence Area	9.4 km²	10.4 km²
Licence duration	2024 - 2039	2024 - 2039
Maximum annual tonnage	250,000 (in total; with no more than 150,000 tonnes from Welsh waters)	250,000
Maximum total extraction (15-year tonnage)	3,750,000	3,750,000

This ES has been prepared to support the marine licence applications. ABPmer, supported by Wessex Archaeology, has been commissioned to prepare this ES report, which documents all the relevant EIA information in accordance with the scope detailed in Schedule 3 of the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended).

During the scoping phase, consultation was undertaken with the MMO and NRW. A consultation log is provided in Appendix A. Appendix A.3 contains a summary of the principal legislation and requirements in relation to these marine licence applications. The information provided in this ES will also inform an Appropriate Assessment (AA) as part of a Habitats Regulations Assessment (HRA) under the Conservation of Habitats and Species Regulations 2010 (as amended) (see 'Appropriate Assessment signposting document' in Appendix C). A Water Framework Directive (WFD) Assessment has also been undertaken (see Appendix D). A Marine Plan Conformance Assessment is provided in Appendix E. The desk-based assessment undertaken to support the archaeological assessment presented in Section 14 has been appended as Appendix F.

1.2 Legislative basis

The marine licensing system under the Marine and Coastal Access Act 2009 came into force on 6 April 2011. This system consolidated and replaced a number of previous statutory controls, including licences under the EIA and Natural Habitats (Extraction of Minerals by Marine Dredging) Regulations 2007. Schedule 3 of The Marine Works (EIA) (Amendment) Regulations 2011 identifies information to be included in an ES. Table 1-2 lists these requirements and signposts where the information can be found in this ES.

A summary of the principal legislation and requirements is provided in Appendix A.3. These have been specifically identified, as appropriate, in the relevant sections of this ES. All relevant national, regional and local planning policy and guidance that relates to Bedwyn Sands and NMG have also been fully taken into account. A review of the key aspects of this policy and guidance is also provided below.

Table 1-2 Environmental Statement scope according to the Marine Works (EIA) Regulations (MWR) and signposting for this report

Schedule Reference	Requirements for ES	Chapter or Section of ES
1	A description of the project, including in particular:	1 and 3
	a) A description of the location of the development.	1 and 3.1
	b) A description of the physical characteristics of the whole development, including, where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases.	3
	c) A description of the main characteristics of the operational phase of the development (in particular any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used.	3
	d) An estimate, by type and quantity, of expected residues and emissions such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities and types of waste produced during the construction and operation phases.	4.1, 5-18
2	A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an	2.3

Schedule Reference	Requirements for ES	Chapter or Section of ES
	indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.	
3	A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.	Second Subsections of 5-19
4	a) A description of the factors specified in regulation 4(2) (of the Town and Country Planning EIA Regulations) and 21A(2)(a) (of the Marine Works EIA Regulations) likely to be significantly affected by the development:	5-19
	b) Population, human health;	Scoped out, 18
	c) Biodiversity (for example fauna and flora);	7-11
	d) Land (for example land take), soil (for example organic matter, erosion, compaction, sealing);	Scoped out/15, 5, 8
	e) Water (for example hydromorphological changes, quantity and quality);	5 and 6
	f) Air, climate (for example greenhouse gas emissions, impacts relevant to adaptation);	16
	g) Material assets;	12, 13, 15, 17
	h) Cultural heritage, including architectural and archaeological aspects; and	14
	i) Landscape.	Scoped out
5	A description of the likely significant effects of the development on the environment resulting from, inter alia:	Fourth sub-section of 5 and third sub-sections of 6-18
	a) the construction and existence of the development, including, where relevant, demolition works;	Not applicable/ scoped out
	b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;	2.3, 3.2; fourth sub-section of 5 and third sub-sections of 6-18 (where applicable)
	c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;	Fourth sub-section of 5 and third sub-sections of 6-18 (where applicable)
	d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);	18.3, 14.3, fourth sub-section of 5 and third sub-sections of 6-11
	e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;	5.3, 19

Schedule Reference	Requirements for ES	Chapter or Section of ES
	f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;	16, not applicable
	g) the technologies and the substances used.	3.1 - 3.4
5 and 6	The description of the likely significant effects should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the development.	Fourth sub-section of 5 and third sub-section of 6-19
6 and 7	A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.	4, first sub-section of 5-19
7 and 8	A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases.	Fourth sub-section of 5 and third sub-section of 6-19; 20
8 and 9	A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned.	Third sub-section of 6, 8-13
9 and 10	A non-technical summary of the information provided under paragraphs 1 to 8/9.	Following preface
10 and 11	A reference list detailing the sources used for the descriptions and assessments included in the environmental statement.	Provided at the end of each ES chapter

1.2.1 Habitats Regulations Assessment

The Conservation of Habitats and Species Regulations (2017) (as amended) (the 'Habitats Regulations')[1], require an Appropriate Assessment (AA) to be undertaken for any plan or project likely to have a significant effect on a European offshore marine site or a European site[2] (collectively referred to in this report as "Protected Sites") either alone or in-combination with other plans or projects. The respective lead Competent Authority is responsible for undertaking an AA of the implications of the proposals with respect to the site's conservation objectives.

1 Following the UK leaving the EU, these have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 - Available at: http://www.legislation.gov.uk/ukdsi/2019/9780111179512/contents (accessed June 2023).

2 The HRA also considers likely significant effects on any European sites proposed for designation, including candidate Special Areas of Conservation (cSACs) and proposed Special Protection Areas (pSPAs), as well as Sites of Community Importance (SCIs) and Ramsar sites (which are also subject to HRA under UK Government policy). In addition, likely significant effects on any sites not currently within a designation process, which clearly meet the criteria for classification and which have been consulted upon are considered.

The following international nature conservation designations, specifically SACs, SPAs and Ramsar sites, are located within the wider study area (see Section 7 for more detail):

- Severn Estuary/Môr Hafren Special Area of Conservation (SAC);
- Severn Estuary SPA; and
- Severn Estuary/Môr Hafren Ramsar site.

Together, these sites form the Severn Estuary/Môr Hafren European Marine Site (Natural England and CCW, 2009), which protects the following features:

- Estuaries;
- Intertidal mud and sandflats;
- Saltmarsh;
- Reefs;
- Subtidal sandbanks;
- Migratory fish; and
- Birds (overwintering and on passage).

All other international nature conservation designations are located over 10 km from the aggregate Areas.

As noted above, the information provided in this ES will assist in informing an AA as part of an HRA, and relevant information has been provided in an 'Appropriate Assessment signposting document' in Appendix C. Based on this information, it is considered that the proposed activity will not have an Adverse Effect On Site Integrity (AEOI) either alone or in-combination with other plans and projects.

1.2.2 Water Framework Directive Assessment

In order to conform with the Water Environment (WFD) (England and Wales) Regulations 2017 (known as the Water Framework Regulations[3;] UK Government 2019), a Water Framework Directive (WFD) Assessment has also been undertaken (see Appendix D).

Bedwyn Sands and NMG Areas are located within the Severn River Basin District (Environment Agency, 2022), and overlap the Welsh Severn Lower transitional water body (ID: GB530905415401). The Severn Lower transitional water body is classified as a heavily modified water body (HMWB). This means 'ecological potential' is applied rather than 'ecological status'. The current (2021) overall status of the water body is 'moderate', based on 'moderate' ecological potential and 'moderate' chemical status (NRW, 2023).

With respect to Welsh water bodies, the Wye (ID: GB530905415406) and Usk (ID: GB530905415404) transitional water bodies all flow into the Severn Lower transitional water body. Each of these water bodies have a current (2021) overall status of 'moderate' status with a 'moderate' ecological potential and 'high' chemical status (NRW, 2023). The Severn Middle (ID: GB530905415402) and Bristol Avon (ID: GB530905415405) also flow into the into the Severn Lower transitional water bodies. Each of these have a 'moderate' ecological potential, and a (2019) chemical status of 'fail' (Environment Agency, 2023) (see Section 6.2 for more detail).

The Severn Lower transitional water body flows into the Bristol Channel Inner North (GB641008660000) and the Bristol Channel Inner South (GB640807670000) coastal water bodies. The current (2021) overall status of the Bristol Channel Inner North water body is 'moderate', based on 'moderate' ecological status

3 Following the UK leaving the EU, the main provisions of the WFD have been retained in English law through the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.

and 'high' chemical status (NRW, 2023). The current (2023) status of the Bristol Channel Inner South water body is a 'moderate' ecological status and a (2019) chemical status of 'fail' (Environment Agency, 2023).

The WFD assessment concludes that the proposed activity is unlikely to result in non-temporary (i.e. permanent) effects on WFD parameters and that deterioration to the current status of the Severn River Basin District and Welsh Severn Lower transitional water bodies is not predicted. Furthermore, it is concluded that the proposed activity is unlikely to prevent these water bodies from achieving long-term future WFD status objectives.

1.2.3 Marine Conservation Zones

A Marine Conservation Zone (MCZ) Assessment in relation to MCZs established as a consequence of the Marine and Coastal Access Act 2009 has not been prepared, as no MCZs lie in close proximity to Bedwyn Sands or NMG Areas. The nearest designated MCZ is the Bideford to Foreland Point MCZ, which is more than 60 km southwest of the Areas (see Section 7.2 for more detail).

1.2.4 Marine Plans

Both Bedwyn Sands and NMG are within the Welsh National Marine Plan Area and Bedwyn Sands also overlaps the area covered by the English South West Inshore Marine Plan. A marine plan conformance assessment has been undertaken to ensure relevant bodies are provided, with a holistic analysis of the acceptability of aggregate extraction within Bedwyn Sands and NMG in policy terms and how it contributes towards the achievement of specific policies. This document is provided in Appendix E.

1.3 Report structure

The structure of this ES is as follows:

Non-Technical Summary (NTS): Included at the beginning of the ES to summarise the contents of the main document and is also available as a separate document.

Section 1	**Project Summary**: Brief project summary and background information, the study area and the information that has been provided in the ES.
Section 2	**Project Need and Alternatives**: Background on marine aggregates and historic extraction in the area, together with an outline of the need for the proposed works and alternative options considered by Breedon Group.
Section 3	**Project Description and Methodology**: A description of the proposed aggregate extraction works.
Section 4	**Impact Assessment Approach**: The key issues identified during the scoping phase of the project and assessment methodology employed.
Sections 5-18	**Impact Assessments**: Baseline information is presented together with predictions of potential impacts arising from the proposed extraction of marine aggregates on the existing environment. The significance for each potentially affected environmental receptor is assessed.
Section 19	**Cumulative and In-combination Effects**: Assessment of the cumulative and in-combination impact(s) of proposed aggregate extraction from Bedwyn Sands and NMG together with other plans and projects in the wider area.
Section 20	**Mitigation and Monitoring:** A summary of the potential impacts and mitigation measures that would avoid or reduce potential impacts, including monitoring requirements.
Section 21	**Conclusions**.

1.4 References

Environment Agency (2022) Severn river basin district river basin management plan: updated 2022 [Online] Available at: https://www.gov.uk/guidance/severn-river-basin-district-river-basin-management-plan-updated-2022 [Accessed September 2023].

Environment Agency (2023) Catchment Data Explorer [Online] Available at: https://environment.data.gov.uk/catchment-planning [Accessed August 2023].

Natural England and Countryside Council for Wales (2009) The Severn Estuary / Môr Hafren European Marine Site. Natural England and the Countryside Council for Wales' advice given under Regulation 33(2)(a) of the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. June 2009.

Natural Resources Wales (NRW) (2023) Water Watch Wales [Online] Available at: https://waterwatchwales.naturalresourceswales.gov.uk/en/index.html [Accessed September 2023].

UK Government (2019) Floods and Water (Amendment etc.) (EU Exit) Regulations 2019. [online] Available at: https://www.legislation.gov.uk/uksi/2019/558/contents/made [Accessed September 2023].

2 Project Needs and Alternatives

In this section, a brief background to marine aggregates extraction in South East Wales and the Severn Estuary is provided (Section 2.1). Thereafter, the existing situation and historic extraction is described (Section 2.2), and finally alternatives to extracting marine aggregates from Bedwyn Sands and NMG are considered in Section 2.3.

2.1 Background to marine aggregates extraction

2.1.1 Marine aggregates

Marine aggregates are essential minerals which are widely used in concrete for the construction of homes, schools, hospitals and infrastructure. They are also used for beach nourishment. Government policy and plans (HM Government, 2011; Welsh Government, 2002, 2019) recognise that marine aggregates play a key role in servicing the nation’s demand for construction aggregate and supplying materials for the maintenance of coastal and flood protection defences required for climate change adaptation. Marine aggregates also contribute to energy security and economic development through provision of fill for major coastal infrastructure projects, for example ports, renewable energy and nuclear energy projects.

Land-based and marine-based construction aggregate resources are unevenly distributed, and many regions are heavily dependent on supplies from other areas. Marine aggregates contribute to the diversity of supply and deliver high quality aggregate into the centre of areas of high demand with minimum disruption.

The UK Marine Policy Statement (see Appendix A.3 for further detail) considers marine aggregates to present reduced impacts on local communities compared to the extraction of land-won aggregates, in particular with regard to the extraction process and transportation (HM Government, 2011). One of the main benefits of using marine sources is that vessels can deliver aggregates directly to wharves in urban areas, reducing pollution and road congestion (BMAPA and TCE, 2017).

2.1.2 Marine aggregates extraction in South East Wales and the Severn Estuary

The aggregates sector policies in the Welsh National Marine Plan (WNMP) (Welsh Government, 2019) set out the Welsh Government’s strategic level policy in relation to the extraction of marine sand and gravel for aggregates from Welsh waters. The WNMP recognises that ‘*marine aggregates play a strategically important role in the national and local supply of aggregates predominantly for use in construction projects*’.

The English South West Inshore Marine Plan acknowledges that there are marine aggregate exploration and option areas in the Bristol Channel and has three policies in place relating to safeguarding marine aggregate licence areas (policy codes: SW-AGG-1; SW-AGG-2; and SW-AGG 3) (MMO, 2021).

The pattern of supply of sand and gravel for construction purposes in South East Wales is unique in the UK because of its current and historic dependence on marine dredged resources. The fine aggregate dredged from the Severn Estuary and Bristol Channel is considered to be of high quality with virtually no outsize wastage and significant manufacturing and production benefits (Welsh Government, 2004). There is no active land-based extraction of sand and gravel in South East Wales, although fine material from crushed rock quarries satisfies part of the demand (Welsh Government, 2002).

Between 2001 and 2010, marine aggregate landings within South East Wales accounted for more than 96% of total sand production. Additionally, the 2014 Regional Technical Statement for Wales included discussions with The Crown Estate which suggested that similar production levels are likely to continue in future years (in line with the current iMADP and the associated Welsh Assembly's 2002 Position Statement on sand and gravel supply for South East Wales). This has been reinforced by the latest (2020) Regional Technical Statement for Wales which reports that in South East Wales, marine aggregate landings accounted for 100% of all sand and gravel production between 2007 and 2016. Additionally, the latest Regional Technical Statement for Wales (2020) stated:

> *"For the time being, it seems reasonable to suppose that marine-dredged aggregates will continue to supply a similar proportion of overall demand as they have done over the last decade"* (Cuesta Consulting Limited, 2020).

Bedwyn Sands and NMG lie within The Crown Estate 'South West Region', encompassing the South West of England and South Wales. In 2019, (excluding Bedwyn Sands) seven aggregate extraction licences, covering 101.5 km² of seabed and making up approximately 10% of licensed aggregate extraction areas in England and Wales, were active in the South West region.

The total amount of aggregate extracted from the region in 2019 was approximately 1.4 million tonnes (Mt) from a permitted licensed tonnage of 2.7 Mt. In 2019, 99.8% of the aggregate extracted in the South West region was delivered to the South West (of this, 49.4% was landed into Welsh ports and 50.4% into English ports) (The Crown Estate, 2019; 2020). It should be noted that Bedwyn Sands would have been excluded, as it is not a Crown Estate area.

With specific regard to the Severn Estuary (taken as the area from Flat Holm and Steep Holm upstream to Frampton-on-Severn), there are currently five sites licensed for aggregate extraction (North Middle Ground (Areas 455 and 459), Bedwyn Sands, North Bristol Deep (Area 470), and Culver Sands Extension (Area 526). The active dredge area Severn Estuary covers 28.91 km², representing approximately 23% of the total area licensed across The Crown Estate 'South West Region' in 2019 (The Crown Estate, 2019), and less than 3% of the total area licensed by The Crown Estate in England and Wales in 2019. Extraction took place across 7.85% of the active dredge area in 2019.

2.2 Existing situation and historic extraction

Breedon Group is applying for permission(s) to continue to undertake aggregate extraction at the Bedwyn Sands and NMG Renewal Areas. The resources currently extracted from the Licence Renewal Areas are used in the construction industry, such as for ready-mix concrete and mortar. Although not historically used in coastal defence and beach nourishment, it is feasible that the material could be used for this purpose in the future, as sand from other licences in the Severn Estuary/Bristol Channel has been used for such purposes in the past (see Section 2.3 for more detail). The recent extraction volumes at Bedwyn Sands and NMG are detailed in Table 2-1. The existing marine aggregate licence conditions for Bedwyn Sands and NMG are detailed in Table 2-2.

Table 2-1 Recent extraction volumes at Bedwyn Sands and NMG (rounded to the nearest tonne)

Annual Extraction (tonnes)						
Licence Area	2017	2018	2019	2020	2021	2022
Bedwyn Sands	14,125	39,326	38,331	26,940	42,065	51,569
North Middle Ground - 455 North Middle Ground - 459	-	162,099	150,094	185,424	180,990	163,672

Table 2-2 Existing conditions of Licence Renewal Areas under consideration

Licence Area	Area	Licence Start Date	Licence Expiry Date	Maximum Total Extraction	Maximum Annual Extraction
Bedwyn Sands	**9.4 km² total** (4 km² exclusion zone, 3.5 km² Welsh waters and 1.9 km² English waters)	2017	28/07/2024 (MMO) 02/05/2024 (NRW)	1,750,000 tonnes	250,000 tonnes (in total; with no more than 150,000 tonnes from Welsh waters)
North Middle Ground - 455	**4.16 km² total** (including 1.5 km² exclusion zone)	Jan 2017	Jan 2024	1,750,000 tonnes	250,000 tonnes
North Middle Ground - 459	**6.15 km²**	Jan 2017	Jan 2024		

2.3 Consideration of alternatives

The EIA process requires the developer to consider alternatives to the proposed scheme, namely alternatives which will be able to provide the same extraction volumes and, thus, maintain the status quo and continue to contribute to the supply of marine aggregates for local construction and potential coastal defence projects. Furthermore, the implications of not applying for a licence to dredge aggregates from Bedwyn Sands and NMG (i.e. 'do nothing' scenario) also needs to be considered.

The following sections describe the alternative options that have been considered by Breedon Group.

2.3.1 Do nothing

One option would be to 'do nothing', i.e. allow the existing licences to expire and for the associated aggregate dredging at Bedwyn Sands and NMG to cease.

The dredging of marine aggregates is a well-established practice and the resources produced are delivered to a number of established markets where a continuity of supply is required. The 'do nothing' option has implications for meeting the existing and future needs of the aggregate industry as well as impacts with regards continuation of well-paid/ skilled employment in the South Wales region. Demand is driven by the economy and the consequent level of local and regional development activity is, therefore, variable and difficult to predict - consequently, there is a need for flexibility and extraction volumes can significantly vary year on year. A decline in the supply of marine aggregates to meet this demand could lead to increased transportation distances and lead to higher unit costs of aggregate for construction projects and builder's merchants. Therefore, the 'do nothing' option is not considered to be viable as it would not allow Breedon Group to continue to meet the needs of their customers in a cost-effective manner.

2.3.2 Alternative sources of aggregates

Marine policy/plans

The Marine Policy Statement (HM Government, 2011) recognises that the UK has some of the best resources of marine aggregates in the world, with marine sand and gravel making a crucial contribution to meeting the nation's demand for construction aggregate materials, essential for the development of the built environment. It states that:

"...there are often no practicable alternative sources to marine aggregates for the maintenance of coastal defences required for climate change adaptation. Marine aggregates contribute to energy security and economic development through provision of fill for major coastal infrastructure projects, for example ports, renewable energy and nuclear energy projects.

Land-based and marine-based construction aggregate resources are unevenly distributed, and many regions are heavily dependent on supplies from other areas. Marine aggregates contribute to diversity of supply and deliver high quality aggregate into the centre of areas of high demand with minimum disruption."

As noted above, The Welsh Government considers marine aggregates to be an important source of aggregates for South East Wales; this is highlighted in the WNMP, which furthermore notes that:

"Marine aggregates resources are widely distributed throughout Welsh waters; however, the majority of extraction has historically taken place in the Bristol Channel, Severn Estuary and off North Wales. Marine aggregates play a strategically important role in the national and local supply of aggregates, predominantly for use in construction projects. The sector therefore makes a critical contribution to the Welsh economy, providing both direct employment and secondary employment in supporting activities including ship building and repair, processing of aggregates at wharves and transportation and manufacture of products such as ready-mixed concrete and concrete products, asphalt and mortar from marine aggregates."

The WNMP considered that:

"... reliance on the use of marine aggregates in Wales for construction and (according to demand) capital projects and beach nourishment will continue for the foreseeable future and for the lifetime of this Plan.

Demand for marine aggregates materials is closely linked to the construction sector and the wider economy. It is likely to be influenced significantly by large scale infrastructure projects, the need for soft engineering defences (such as beach replenishment), and for coastal flood and erosion defence, demand for which may increase as a result of climate change."

The WNMP furthermore notes that:

"Marine aggregates are a finite marine natural resource and their extraction and rate of use need to be sustainably managed. However, this Plan recognises that an adequate and continuing supply of aggregates is essential to meet demand for construction needs for the built environment."

As noted above, the resources currently extracted from Licensed Areas are directed for use in construction aggregates and concrete products. They are also suitable for use in beach nourishment projects, if required. Breedon Group foresees an ongoing requirement for these resources in order to service established markets into the future.

Marine aggregates can present reduced impacts on local communities compared to the extraction of land-won aggregates, in particular with regard to the extraction process and transportation. Substantial volumes of marine aggregates are landed on wharves close to where they are needed and locally distributed by rail, water (using barges) and road. Wider social and economic benefits include skilled, stable employment and the generation of income through the construction industry supply chain (HM Government, 2011).

The importance of aggregate extraction activities is outlined in the Marine aggregates Capability & Portfolio 2021 (TCE, 2021). As outlined in Section 2.1.2, the South West Inshore Marine Plan has three policies in place relating to safeguarding marine aggregate licence areas (policy codes: SW-AGG-1; SW-AGG-2; and SW-AGG 3) (MMO, 2021). The Welsh National Marine Plan also has sector specific policies (AGG_01; SAF_01; and SAF_02) which support and safeguard marine aggregates (Welsh Government, 2019). Additionally, the National Planning Policy Framework (Department for Communities and Local Government (DCLG), 2023) states that "it is essential that there is a sufficient supply of minerals to provide the infrastructure, buildings, energy, and goods that the country needs.

Land-based (primary) sources

Land based primary aggregates are produced from naturally occurring terrestrial mineral deposits, extracted specifically for use as aggregates and used for the first time. Most land-won construction aggregates are produced from hard, strong rock formations by crushing to produce crushed rock aggregates or from naturally occurring particulate deposits such as sand and gravel. In 2017, some 64% of the total supply of aggregates was obtained from natural deposits on land (and 6% from marine sources and 30% from recycled and secondary sources) (British Geological Survey (BGS), 2019).

Land based primary aggregate resources are not evenly distributed, and many regions are heavily dependent on supplies from other areas. London, for example, derives much of its non-marine dredged aggregate in the form of crushed rock, which is mostly sourced from the southwest region of England (Greater London Authority for the London Boroughs, 2019); although the East Midlands also have substantial reserves (BGS, 2019)

There are furthermore numerous planning constraints associated with aggregate extraction from land-based sources. These include the loss of agricultural land, impacts on landscape and amenity, increased levels of noise and dust, and an increase in road traffic (with associated secondary impacts). If construction and coastal defence demand is to be met, it is vital to ensure continuity of marine supply, especially given the pressure on constrained and declining land-based sources (Emu, 2012).

Recycled and secondary aggregates

Recycled and secondary aggregates are making an increasingly important contribution to sustainable construction by reducing demand for primary aggregates. Secondary aggregates are materials which are the by-products of extractive operations and are derived from a very wide range of materials. Recycled aggregates can be sourced from construction and demolition waste, highway maintenance (asphalt planings), used railway ballast, excavation and utility operations. The quality of the recycled aggregate is dependent on the quality of the materials that are processed, the selection and separation processing used, and the degree of final processing that these materials undergo (Mineral Products Association, 2021).

When compared to the marine aggregates extracted from Bedwyn Sands and NMG, the recycled or secondary materials are not necessarily suitable for the specific end uses that the resources extracted from these areas will be directed to. The availability of secondary or recycled material is also spatially constrained, as the transport of material over a significant distance could more than offset any sustainability benefits and increase the carbon footprint. As a general rule, the BGS considers transporting aggregates by road for more than 43 km will result in the aggregates becoming economically unviable (BGS, 2019).

Some 30% of total aggregates demand in the UK is generally supplied by alternative materials, mainly construction and demolition waste, and Britain is one of the leading countries in Europe in this regard (BGS, 2019). However, it is thought that most of the material that is suitable for aggregates use is being recovered and used. BGS (2019) notes that '*there are large resources of some secondary materials, such as china clay sand and slate waste, but these are remote from major markets and there are significant economic obstacles to creating the transport infrastructure to overcome this problem. Consequently primary aggregates will continue to be required to supply a major proportion of UK demand*'.

Other aggregates dredging areas in the region

Alternative marine sources of supply could potentially replace the prospective contribution from Bedwyn Sands and NMG. Away from the Bristol Channel/Severn Estuary, the nearest existing dredging areas are 500 to 600 km away steaming-wise, immediately west of the Isle of Wight in England, and at the mouth of the Dee Estuary in Northern Wales. In the Bristol Channel/Severn Estuary, there are currently six licensed dredging areas, including Bedwyn Sands and two areas at NMG. Of the six licensed areas, four are located in the Severn Estuary, and two in the Bristol Channel. However, excluding Bedwyn Sands and NMG, the other aggregate licence areas in the region are operated by other companies.

If alternative marine sources were used, this would essentially displace the environmental impacts associated with the extraction of marine aggregates in Bedwyn Sands and NMG to alternative areas and, thus, such alternative sources are unlikely to constitute better alternatives. For example, as the key ports/wharves where aggregates in the region are discharged are in the Severn Estuary, targeting resources in the Bristol Channel rather than the Severn Estuary would generally lead to increased steaming distances, and additional related environmental impacts. Furthermore, customers often have very specific requirements regarding the sediment composition from aggregate extraction which often cannot be met from other areas.

2.3.3 Conclusion

In conclusion, it is considered that there is a requirement for the continued and increased supply of marine aggregates from the Severn Estuary. Alternatives to obtaining licences to extract marine aggregates from Bedwyn Sands and NMG have been considered. However, such alternatives are deemed either inappropriate, economically unviable, or to not having a lesser environmental impact or to result in a higher carbon footprint than the extraction of materials from Bedwyn Sands and NMG.

2.4 References

British Geological Survey (BGS) (2019) Construction Aggregates. Mineral Planning Factsheet. BGS, Nottingham, 32p.

British Marine Aggregate Producers Association (BMAPA) and The Crown Estate (2017) Good Practice Guidance: Extraction by Dredging of Aggregates from England's Seabed. BMAPA and The Crown Estate, London, 24p.

Cuesta Consulting Limited (2020) Regional Technical Statement for North Wales and South Wales: 2nd Review. C/WG/053.

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3 Project Description and Methodology

In this section, the project description is provided in Section 3.1, the origin and nature of the deposits is described in Section 3.2, dredging methods are detailed in Section 3.3, the dredging programme is shown in Section 3.4, and finally the best practice procedures and standard mitigation measures are summarised in Section 3.5.

3.1 Project description

Breedon Group is applying to renew permissions for the extraction of aggregates from Bedwyn Sands and NMG (Areas 455 and 459). The location of the Licence Renewal Areas is shown in Figure 1-1, and the coordinates are provided in Table 3-1. The renewal applications seek to continue aggregate dredging, from each of the sites, at the same maximum annual extraction rates as are presently licensed (Table 3-1).

Breedon Group is seeking 15-year licences for both Welsh and English waters, recognising that the current licence terms for the Areas are seven years. An annual maximum offtake tonnage of 250,000 tonnes is proposed for each area, permitting up to a maximum of 3,750,000 tonnes for each area over the licence term.

Table 3-1 Coordinates of Bedwyn Sands and NMG (referenced to WGS 1984)

Area	Latitude (°N)	Longitude (°E)	Licence Area	Licence Duration	Maximum Annual Tonnage	Maximum Total Extraction (15-Year Tonnage)
Bedwyn Sands	51°32.5938	-2°47.3922	9.4 km²	2024 - 2039	250,000 (in total; with no more than 150,000 tonnes from Welsh waters)	3,750,000
	51°33.1392	-2°46.5366				
	51°33.1596	-2°43.3524				
	51°31.4274	-2°44.2500				
	51°31.4352	-2°44.7084				
North Middle Ground - 459	51°31.0000	-2°52.0000	10.4 km²	2024 - 2039	250,000	3,750,000
	51°31.6000	-2°48.6000				
	51°31.1460	-2°48.3282				
	51°29.9040	-2°52.0000				
North Middle Ground - 455	51°30.0300	-2°52.0000				
	51°31.0000	-2°52.0000				
	51°31.0000	-2°54.0000				
	51°30.0300	-2°54.0000				

Figure 3-1 shows the isopach (resource thickness) information for the resource available across the Licence Renewal Areas. The isopach data is based on the survey information collected from 2021 (2022 data has been collected but has not yet been processed) and incorporating the original prospecting surveys of the site. The assessment of resource indicates that, at present, resources of over 10 m in thickness can be found across large proportions of the Licence Renewal Areas and extending up to 16 to 18 m in places. It should be noted that, due to the high rate of sediment mobility in the Severn Estuary, sand thicknesses vary on an annual or even shorter timescale (see Section 5.2 for further detail).

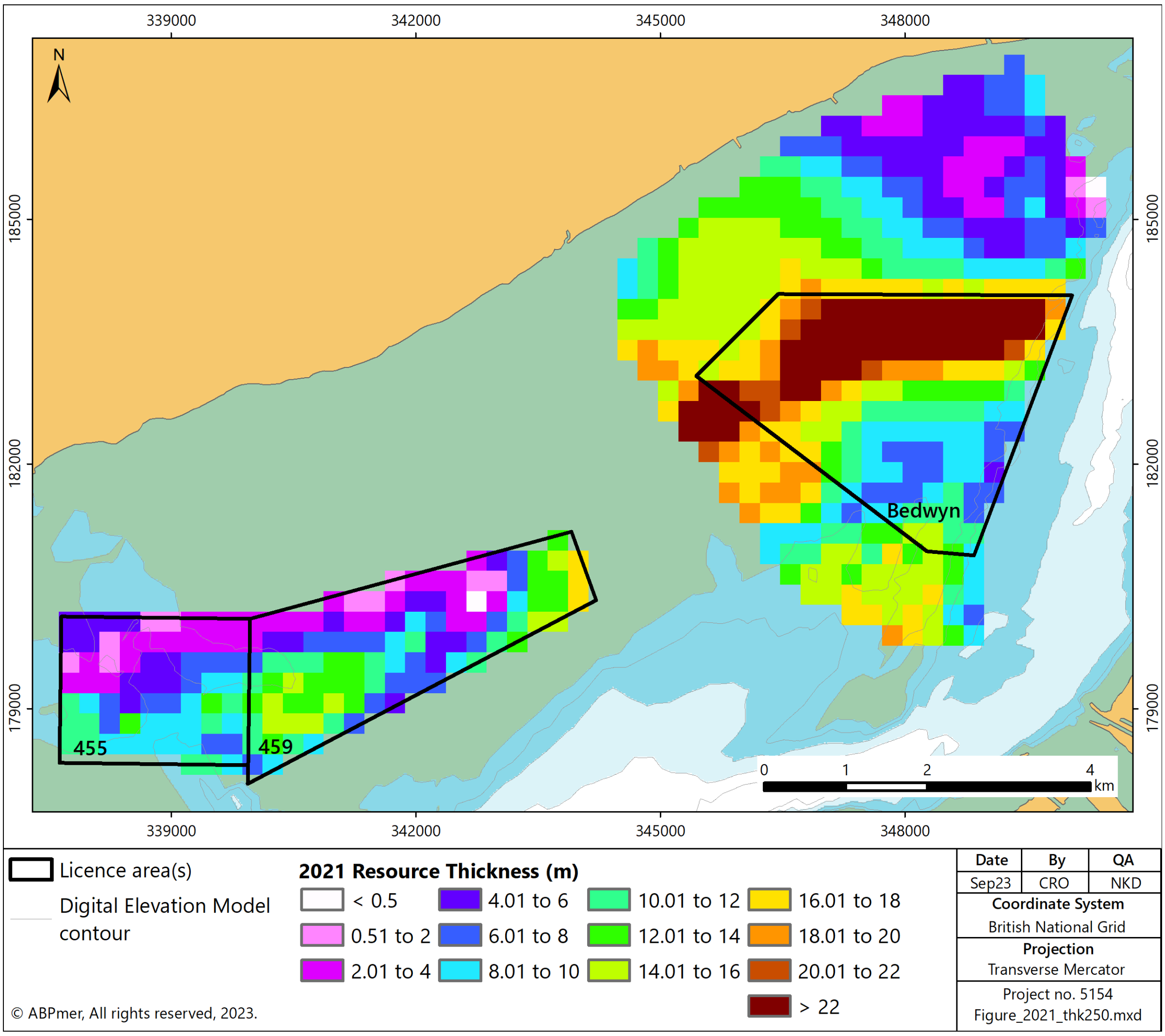

Figure 3-1 **Resource thickness across the Renewal Areas (from 2022 survey)**

3.2 Origin and nature of deposits

Both Bedwyn Sands and NMG represent an intertidal sandflat i.e. they are not covered by seawater at all times; they are described as a discrete intertidal 'sandflat' feature and not a classic 'sandbank' having no distinct 'crest' (ABPmer, 2007). Both areas make up one of the many intertidal sandbank and sandflat features known as the Middle and Welsh Grounds within the Upper Severn Estuary. These features constitute an interconnected series of banks and flats, forming part of the same geomorphologic system. The sand resources within this system lie within a 'sediment sink' of Holocene deposits, whereby sand is the dominant material (HR Wallingford, 2003). NMG is located at the up-drift end of a sediment transport pathway, which extends through the Severn Estuary (McLaren and Collins, 1989). It is composed of a range of sand- to pebble-sized sediment, which can be found sorted as a result of tidal flows in the area (HR Wallingford, 1998). At NMG and Bedwyn Sands, it is the medium to coarse sand and the well-sorted medium sand respectively that are of interest to aggregate companies. For a more detailed description of the morphology of the area, please refer to Section 5.

3.3 Dredging methods

Trailer suction hopper dredging (TSHD) will continue to be used to extract marine aggregates which are primarily sand from Bedwyn Sands and NMG. The aggregate vessel operated by Breedon Group carries an average 1,100 tonnes of wet sand and has a 40-tonne re-handling machine allowing it to discharge directly onto quaysides. This vessel currently unloads primarily at Newport, but some loads are also transported to Chepstow, Cardiff and Avonmouth.

TSHD is a common method of extracting marine aggregates. It involves deploying trailing dredge pipes (one or two at once, though typically only one) with dragheads onto the seabed, while steaming the dredger at slow speed, typically 0.5-1.5 knots (or 0.25-0.75 m/s). The draghead and dredger's pipework is connected to a powerful inboard or outboard centrifugal pump. As sediment, mixed with seawater, is pumped up the pipe into the hopper, each draghead creates a shallow furrow in the seabed. Its penetration depth depends on the nature of the seabed and the speed of the dredger, but individual furrows are typically around 1.5 to 3 m wide and up to 0.5 m deep. Without replenishment of the extracted material, in time, dredging can create a localised lowering of the seabed within the licensed areas. However, the sandbanks at Bedwyn Sands and NMG are stable and replenishing in nature (Velegrakis *et al*., 2001; ABPmer, 2015) and this is reflected in the annual monitoring surveys and analysis (e.g. ABPmer, 2022).

As aggregate is pumped into the hopper, it settles and gradually displaces the water which overflows through spillways located on either side of the cargo hopper, back into the sea. Due to high turbulence in the hopper, a proportion of the fine sediment (e.g. fine sands, silts and clays), where present in the aggregate, is also returned to the sea via the spillways, potentially forming a sediment plume.

Aggregate dredgers can produce a cargo in two different ways. Firstly, the cargo can be produced as it is dredged from the seabed, referred to as 'all in'. Alternatively, the cargo can be partially sorted by the dredger as it is loaded by a process known as screening; this process enables a degree of control on the sand:gravel ratio of the dredged sediment. Screening involves passing the seawater and entrained sand and gravel over a plastic or steel screen mesh, where either the gravel or sand fraction can be preferentially retained within the vessel's hopper. The rejected component is directed overboard into the water column, where it forms part of the plume and settles back to the seabed. As a result of the increased sedimentation, longer loading time and increased wear and tear on the dredger associated with this process, use of screening will continue to be minimised at the Bedwyn Sands and NMG sites.

However, on the limited occasions where screening is required, a 4 mm mesh will be used, with sediment greater in size than this being released on site, where it will settle to the bed immediately below the dredger. When screening is in progress at Bedwyn Sands or NMG, it has been estimated that 3% of dredged material is returned to the seabed.

On completion of the dredging operation, the vessels use their ballast handling equipment to pump out the seawater from the wet aggregate. By the time the vessel arrives at its discharge port, the cargo is dry enough to be discharged and prepared for use ashore in a variety of ways.

Breedon Group is specifically seeking consent to undertake TSHD and screening activities on Bedwyn Sands and NMG. This applied-for consent includes the ability to take core and/or grab samples from the seabed within, and potentially around, Bedwyn Sands and NMG for resource management and monitoring purposes. No hopper washing is proposed.

3.4 Dredging programme

For deliveries to tidal ports or replenishment areas, dredgers load on licensed areas and sail to the wharf or replenishment discharge location to arrive just before high water, discharge their cargo and sail out to load once again. Dredgers therefore work continuously, except when vessels are alongside for maintenance or if rough seas prevent access to an Area. The number of cargoes extracted from Bedwyn

Sands or NMG will be controlled by market demand (up to the maximum licensed tonnages). An average cargo takes approximately 6.5 hours for a round trip leaving and returning to Newport.

In order to run the ships most efficiently, the Licence Renewal Areas need to have 24-hour access, within the constraints of the tidal cycle. Accessibility varies dependent on tidal state and vessel draught (both loaded and unloaded), but in general, vessels can be 'on-site' from around 2 hours before high water (HW) to around 2 hours after HW.

The associated dredging activity assumptions based on the maximum annual average extraction of 250,000 tonnes per year at Bedwyn Sands and NMG are outlined in Table 3-2. This is based on the continued use of the "Penfret" TSHD. However, it should be considered that the annual "maximum" tonnage is unlikely to occur every year (with an average annual extraction of 35,000 for Bedwyn Sands and 170,000 tonnes and NMG since 2017, as detailed in Table 2-1) but is included in the application to allow for periods of high demand and based on a precautionary approach.

Table 3-2 Dredging activity scenarios for Bedwyn Sands and NMG

Item	Scenario	
	Maximum Future Annual Extraction	Average Future (Based on Current Averages)
Bedwyn Sands		
Extraction values (tonnes)	250,000	35,000
Number of cargoes per year	227	32
Total loading time per year (hours)	682	95
Total dredging time per day (hours)	1.9	0.3
Total dredging time per week (hours)	13.1	1.8
Cargoes per day	0.6	0.1
Cargoes per week	4.4	0.6
North Middle Ground		
Extraction values (tonnes)	250,000	170,000
Number of cargoes per year	227	155
Total loading time per year (hours)	682	464
Total dredging time per day (hours)	1.9	1.3
Total dredging time per week (hours)	13.1	8.9
Cargoes per day	0.6	0.4
Cargoes per week	4.4	3

The maximum annual extraction is essentially the annual average of the 15-year tonnage and is considered to be a realistic worst-case scenario in EIA terms. If this were to all be dredged, then equivalent average lowering over the wider features of NMG would be 0.31 m and over Bedwyn Sands 0.52 m (ABPmer, 2023).

3.5 Best practice procedures and standard mitigation measures

3.5.1 Reporting and monitoring

For individual licence areas, marine licences generally require regular monitoring, and reporting, of the dredging activities and returns, as well as the status of the sediment, archaeological and benthic resources. Comprehensive pre-dredge and post dredge studies tend to be required, and, whilst dredging is ongoing, so-called substantive reviews are generally undertaken every five years to summarise and review data and impacts to date.

With regard to seabed characteristics, the Regional Seabed Monitoring Programme (RSMP) approach, which was first initiated in England in 2014/15, is now utilised by British marine aggregates dredging companies to ensure that the seabed remains similar to reference / pre-dredge conditions once dredging has ceased. The premise of the RSMP approach is that if, following dredging, the seabed has a broadly similar sediment character to that which existed before dredging began, then recovery of similar faunal communities will be possible.

At each aggregates dredging area, detailed baseline benthic and sediment sampling would first take place, including from the immediate surroundings, as well as reference stations outside the influence of dredging. Sediment composition is then routinely monitored to check conditions remain favourable for recolonisation. Where sediment conditions change as a result of dredging (and are unlikely to support the return of the original animal community), then management measures can be used to help bring conditions back within acceptable limits (The Crown Estate, 2018; Cooper and Barry, 2017).

At Bedwyn Sands and NMG, RSMP-type monitoring commenced in 2017, when baseline surveys were undertaken according to a sampling grid developed in consultation with Cefas; in 2020, a second survey took place to monitor sediment condition. The results from these surveys informed a 5-year substantive review (ABPmer, 2022a).

As part of the conditions of the planning permission for the current extraction at Bedwyn Sands and NMG, a programme of ongoing monitoring and reporting has been undertaken since 2008. This has included bathymetric and LiDAR surveys, along with benthic sampling including macrofaunal and particle size analysis. Results to date have shown that the present, ongoing dredging activity is not resulting in changes to the resource outside of the envelope of historic variation. Further details of the annual monitoring requirements, and the results obtained from the ongoing analyses, are provided in Section 5 and 8 of the ES.

To reduce potential archaeological impacts, dredging companies observe a code of practice on marine aggregate dredging and the historic environment, developed jointly by BMAPA and English Heritage (now Historic England) (BMAPA and English Heritage, 2003). This protocol means that finds of archaeological interest are reported to relevant regulators; an annual review is furthermore published to report on all finds logged in England during a given year. If any previously unreported wrecks become apparent within the boundaries of a dredging permission area, precautionary exclusion zones, defined in consultation with independent marine archaeological consultants and the regulators, are instituted around them.

3.5.2 Zoning

Active dredge areas

Dredging is restricted to zones of varying sizes, particularly within larger areas. Zoning is encouraged by the Best Practice Guidance (see BMAPA and The Crown Estate, 2017). The zoning guidance states that the intention is to, at any one time, minimise the area available for dredging 'as far as possible through the use of Active Dredge Areas (ADAs). It is now common practice for zoning plans and ADAs to be agreed with the regulators before dredging begins under new marine licences. ADAs are occasionally further subdivided into dredging lanes depending for example on the extent of the aggregate resource.

Exclusion zones and restrictions

Several types of exclusion zones are implemented in aggregate areas, including relating to cables, heritage, nature conservation and resource thickness. With regard to the latter, where the resource is less than 0.5 m thick, exclusion zones are implemented in aggregate areas.

Currently, best practice for the mitigation of environmental impacts from the extraction of marine aggregates is to zone out potentially sensitive nature conservation habitats or species features, as well as archaeological features, through the establishment of exclusion zones (JNCC and Natural England, 2011). Similarly, seasonal restrictions may be introduced to avoid sensitive periods for species features. Exclusion zones are an area around the defined seabed feature within which dredging is not permitted in order to prevent direct damage or disturbance. They may also contain a buffer or margin around the feature as a precaution to mitigate any potential smothering effects or to allow for small positional uncertainties. Exclusion zones are agreed with the regulators and the relevant statutory nature conservation agency either prior to dredging commencing or during the life of the licence as new information presents itself.

Within the Bedwyn Sands Licence Renewal Area, the existing aggregate licence (MMML1516[4]) states that no dredging shall take place north of northing 183000 mN. The condition was included in the existing licence to cover the part of the site in closest proximity to the seagrass beds located along the foreshore to the north of Bedwyn Sands. This licence condition effectively creates an exclusion zone within the Renewal Area. In addition, the existing licence for North Middle Ground Area 455 (MMML1605[5]), states that no dredging will take place within the area defined by these four points:

- 51°31.00N, -2°54'.00E;
- 51°30.42N, -2°54.00E;
- 51°30.60N, -2°52. 92E; and
- 51°31.00N, -2°52.08E.

Breedon Group is not requesting a change to these exclusion zones and as such are effectively looking to continue operating within the area in which aggregate dredging is presently licensed.

Potential impacts associated with dredging within individual licence areas can also be mitigated through voluntary zoning to minimise the areas of seabed being worked (spatial footprint directly impacted). Zoning an area potentially mitigates the effects of the dredging by reducing the area of direct removal of biomass. It also allows parts of an area to be un-dredged, or undergoing benthic re-colonisation, at any particular time. Wherever practicable, the Best Practice Guidance also requires an operator to work areas to commercial exhaustion before moving to new dredging zones, allowing uninterrupted recovery once extraction has ended (BMAPA and The Crown Estate, 2017).

3.5.3 Retaining a layer of sediment

One of the means of mitigating the effect of dredging on marine habitats is a licence condition to leave the seabed sediment post-dredging in a similar physical condition to that present before dredging.

Sediments are furthermore not dredged completely (down to bedrock), but an adequate depth of suitable material is to be left after cessation of dredging as a 'capping layer' (normally a minimum of 0.5 m in depth on average across the dredge area. This is measured across a 250 m by 250 m grid square, at 125 m centres). These mitigation measures (detailed in BMAPA and The Crown Estate, 2017) primarily

[4] Bedwyn Sands Licence Renewal Area 2017 marine licence: https://cdn.cyfoethnaturiol.cymru/media/681585/eia-consent-decision-mmml1516.pdf?mode=pad&rnd=131502042350000000

[5] NMG Licence Renewal Area 2017 marine licence

facilitate the re-colonisation and recovery of benthic communities (JNCC and Natural England, 2011). The existing licenses include conditions on the annual monitoring to flag any areas where resource thickness is approaching 0.5 m, although it is also noted that the dynamic sediment regime across the wider estuary results in significant levels of reworking and transport of material within and between the sand bank features.

3.5.4 Interaction with other users

Dredging operations also have the potential to interact with other users of the sea area, particularly fishermen. Such interactions may result in diminished access to fishing areas and a reduced catch. Spatial mitigation actions to reduce effects on fisheries can include exclusion zones to avoid important fishery sites and targeting of dredging activity in Active Dredge Areas. Key to mitigating the impacts of dredging on other sea users is an effective mechanism for communication and cooperation. These approaches are already successfully implemented across the existing licence areas and will be continued for any subsequent renewal period.

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4 Impact Assessment Approach

An EIA is a process for systematically predicting and evaluating the impacts and effects of a development/activity on the environment can include a number of different stages. Following consultation with NRW and the MMO, and due to the extensive work undertaken as part of the existing permissions for Bedwyn Sands and NMG, the following stages are applicable for this EIA:

- Consultations by the applicant with regulators, stakeholders and interested parties to discuss issues and request baseline information;
- Preparation of a draft ES and submission of a draft ES for pre-application consideration; and
- Submission of the updated and revised final ES and subsequent formal consultation by NRW and MMO with stakeholders.

Data gathering takes place throughout the EIA process outlined above, with the draft ES updated with relevant new data or data which the applicant has become/been made aware of throughout the course of the process. This culminates in the submission of the final ES with the application. As outlined within the EIA regulations, it is perfectly acceptable for the Regulator undertaking the EIA to utilise other data sources they see fit and that the applicant may not have access to.

This ES has been supported by a large resource of literature and data describing the existing (baseline) environmental conditions. The details are defined in individual Sections where necessary.

In this Section, impact zones for aggregate dredging and study areas are discussed in Section 4.1. The scope of this EIA is then summarised in Section 4.2, before the competency and quality standards of the companies commissioned with undertaking this EIA are specified (Section 4.3). Section 4.4 provides a description of the impact methodology applied to this EIA.

4.1 Aggregate dredging impact zones

Aggregate extraction causes direct and indirect impacts in the marine environment and also contributes to cumulative effects (Tillin *et al.*, 2011). The direct and indirect physical impacts of aggregate dredging on the environment are conceptualised in the illustration in Figure 4-1. It is important to note that the tidal residual and far field change in tides and current are not necessarily limited to the areas encompassed by the arrows shown in Figure 4-1 below. The arrows simply denote directions.

Direct impacts are defined as physical effects arising within the footprint of the aggregate dredge areas. The main direct impacts are disturbance effects on the seabed resulting from the passage of the draghead over the seabed, the removal of deposits and the creation of suspended sediment plumes in the water column (Tillin *et al.*, 2011). Sediment plumes can be formed by:

- Draghead: disturbance of the seabed sediment;
- Overspill: where suspended sediment is returned with the water overspill during loading of sediment into the vessel hopper; and/or
- Sediment: discharge following on-board screening.

Indirect impacts result from the deposition of suspended sediment particles from the water column on to the seabed and subsequent effects on the hydrodynamic and sediment regimes (Tillin *et al.*, 2011). The effects of shipping activities such as vessel movements, vessel noise and vibration on marine wildlife arising from extraction are also classified as indirect impacts.

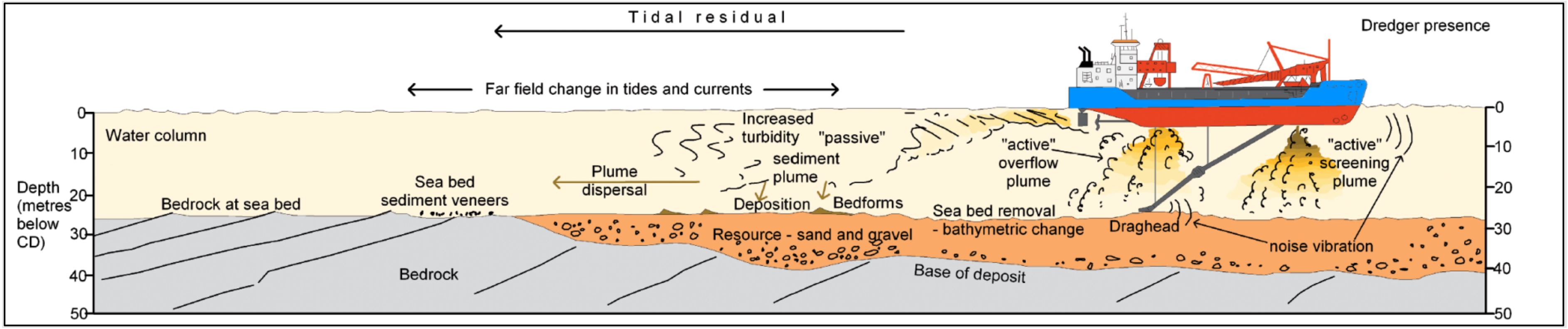


Figure 4-1 **Conceptualisation of aggregate dredging and its direct and indirect impacts on the marine environment**

With regard to the extent of an impact, two impact zones are commonly referred to in the aggregates industry literature: primary and secondary impact zones.

- The Primary Impact Zone (PIZ) refers to the maximum future footprint (i.e. the area where dredging is predicted to occur over the course of the licence). Note: This category includes the effects associated with the passage of the draghead over the seabed including sediment removal.
- The Secondary Impact Zone (SIZ) refers to the local zone(s) where effects that extend beyond the immediate footprint of dredging occur. This is usually associated with the areas where any fine-grained sediment that may be entrained within a dredge plume settles back to the seabed, as well as the areas over which screened sediment may disperse and thus change the seabed or sediment characteristics. For aggregate dredging in the Severn Estuary/Bristol Channel, a maximum secondary impact zone of 500 m has been applied. This is considered scientifically justifiable due to the high tidal flows and natural turbidity observed in the Severn Estuary/Bristol Channel region (MarineSpace, 2015)[6].

The '**study area**' is defined as the area over which the potential direct and indirect impacts of the proposed licence are predicted to occur. In other words, the study area comprises the primary and secondary impact zones referred to above. However, for some receptors a '**wider study area**' has been necessary and these are defined in individual sections of this ES where necessary. For example, underwater noise impacts for fish and marine mammals.

Areas outside the range of any potential impacts from the proposed activity are referred to as reference zones. They are representative of the wider natural environment and form part of the wider study area.

4.2 Impact assessment scope

The following main receptor groups are assessed in this ES (presented in Sections 5 to 19):

- Physical Processes;
- Water and Sediment Quality;
- Nature Conservation;
- Benthic Ecology;
- Fish and Shellfish Ecology;
- Marine and Coastal Ornithology;
- Marine Mammals;
- Commercial and Recreational Fisheries;
- Commercial and Recreational Navigation;
- Marine Archaeology;
- Coast Protection and Flood Defence;
- Air Quality;
- Infrastructure and Other Marine Users;
- Human Health; and
- In-combination/Cumulative Effects.

The pathways assessed for each of these receptors are summarised in Table 4-1.

[6] This is also in line with a proposed methodology for sediment compliance monitoring in the Severn Estuary/Bristol Channel (MarineSpace, 2015).

Table 4-1 Key potential/likely environmental effects considered

Receptor (Section)	Potential/Likely Impact of the Proposed Activity
Physical Processes (5)	▪ Effects on the coastline due to changes in wave height and tidal currents; ▪ Reduction in beach volume from 'draw-down' of material into the dredged areas; ▪ Effects on the coastline due to changes in sediment transport pathways; ▪ Effects on bedforms across the wider study area; and ▪ Cumulative effects on the coast with ongoing dredging in other sites within the study area.
Water and Sediment Quality (6)	▪ Potential changes to suspended sediment concentrations; ▪ Potential changes to dissolved oxygen; and ▪ Potential changes to levels of contaminants in water. ▪ Potential impacts from redistribution of sediment-bound chemical contaminants.
Nature Conservation (7)	▪ Assessed through individual receptor groups (e.g. Benthic species and habitats etc..); HRA Appropriate Assessment (AA) Signposting Document provided in Appendix C).
Benthic Species and Habitats (8)	▪ Potential impacts from seabed removal; ▪ Potential impacts due to the suspended sediment plume; ▪ Potential impacts due to fine sand deposition and dispersion (including bedform); ▪ Potential impacts due to bathymetric changes following dredging; ▪ Potential disturbance due to noise; and ▪ Potential impacts through the introduction of non-native species.
Fish and Shellfish Ecology (9)	▪ Potential impacts of seabed removal on spawning, nursery and feeding grounds (direct and indirect effects); ▪ Potential impacts due to changes in water quality (due to fine sediment plume and fine sand dispersion); ▪ Potential impacts due to noise, vibration and lighting; ▪ Sandeel assessment; and ▪ Herring assessment.
Marine and Coastal Ornithology (10)	▪ Potential indirect effects on waterbirds and marine birds as a result of seabed removal (including prey availability); ▪ Potential impacts on the foraging of marine birds due to suspended sediment plumes; ▪ Potential impacts on the foraging of waterbirds due to fine sand dispersion; ▪ Potential impact of disturbance generated by vessel presence on waterbirds and marine birds (including visual, noise and vibration).
Marine Mammals and Turtles (11)	▪ Potential impacts due to the removal of seabed; ▪ Potential impacts from reduced water clarity due to the suspended sediment plume; ▪ Potential disturbance due to the noise and vibration effects; and ▪ Potential collision risk due to vessel movements.

Receptor (Section)	Potential/Likely Impact of the Proposed Activity
Commercial/Recreational Fisheries (12)	▪ Potential disruption of fisheries activities due to vessel movements; ▪ Potential for fishing gear damage; and ▪ Potential indirect on target fish and shellfish stocks.
Commercial/ Recreational Navigation (13)	▪ Aggregate dredger accident or incident at Bedwyn Sands and NMG; ▪ Aggregate dredger accident or incident whilst on passage between Bedwyn Sands and NMG and berth(s); ▪ Displacement of vessels out of Bedwyn Sands and NMG; and ▪ Water quality impacts from pollutants resulting from accidents, incidents or spillages.
Marine Archaeology (14)	▪ Direct damage to the marine archaeological resource; and ▪ Indirect damage to the marine archaeological resource.
Coastal Protection and Flood Defence (15)	▪ Potential for maintaining source of aggregate for coastal defences and beach nourishment; and ▪ Potential for changes to wave height/exposure to affect coastal protection/flood defence.
Air Quality (16)	▪ Potential for changes in air quality due to aggregate dredger emissions.
Infrastructure and Other Marine Users (17)	▪ Potential impacts of physical processes changes on marine and land-based infrastructure.
Human Health (18)	▪ Potential impacts on human health related to air quality and noise/light pollution
Cumulative and In-combination Effects (19)	▪ Potential cumulative/in-combination effects of project and relevant plans, projects and activities on each receptor.

Four receptor groups and any potential impact pathways related to them were scoped out during the scoping stage as there is no potential for them to be significantly impacted by dredging in Bedwyn Sands and NMG. These are presented in the Table 4-2 below.

Table 4-2 Key receptors scoped out of the EIA during the scoping stage

Receptor	Rationale
Airborne Noise and Vibration	Given the distance from the nearest sensitive receptors and the existing level of aggregate extraction in the area, it has been concluded that there is no impact pathway for humans to be disturbed by noise. The effects of noise and vibration from dredging activity on ecological receptors are considered in Sections 8 to 11.
Landscape/Seascape and Visual	Dredging operations have been occurring in Bedwyn Sands and NMG since 2008 and 2011 respectively. Furthermore, the aggregate extraction work will only result in physical changes to the low intertidal and subtidal environment and, therefore, there will be no change to landscape character or visual appearance. This issue has, therefore, been scoped out.
Light	Given the distance from receptors and the existing level of aggregate extraction in the area, there will be no significant lighting effects due to the dredger activity. Therefore, this issue has been scoped out. Potential light effects on sensitive fish species are covered in the ES (see Section 9.3).

Receptor	Rationale
Terrestrial Ecology	There is no impact pathway by which terrestrial ecology features might be affected and therefore this issue has been scoped out. Potential direct and indirect effects of the aggregate dredging on intertidal and subtidal habitats and species will be considered as part of the ES (see Sections 7 to 8).

4.3 Competency and quality standards

This EIA has been prepared by ABPmer, with support from Wessex Archaeology for the archaeological assessment. The following two sub-sections summarise their respective technical competencies as well as quality standards.

4.3.1 ABPmer

ABPmer is a leading UK marine consultancy that has been advising clients and undertaking applied research for over 60 years. ABPmer employs more than 60 technical staff in its offices in Southampton, across a wide range of marine disciplines, including coastal processes, water and sediment quality, marine ecology, navigation and other sea users. All of ABPmer's technical staff are university educated, and the majority have post graduate qualifications. ABPmer has a wealth of expertise in undertaking EIAs (as well as related assessments such as HRAs and WFD assessments), including many for the aggregates industry. In this context, ABPmer has been awarded an EIA Quality Mark by the Institute of Environmental Management and Assessment (IEMA) for its service excellence in the co-ordination of EIAs and production of ESs. Many of its staff are furthermore members of relevant professional institutes, and ABPmer is a corporate member of IEMA. ABPmer also has considerable experience in conducting numerical modelling studies and preparing CISs for the aggregates sector.

ABPmer's projects are managed in accordance with its quality management system (QMS), which is accredited to ISO 9001, for the delivery of Environmental Consultancy and Research Services. The QMS comprises a manual of procedures to ensure standards for company systems and capabilities, products and customer care.

4.3.2 Wessex Archaeology

Wessex Archaeology specialises in the provision of archaeological and heritage services across the UK and internationally. The Wessex Archaeology Coastal and Marine Team delivers the company's marine archaeological services, supporting offshore renewable energy, marine mineral extraction, ports and harbours, cables, pipelines, flood and coastal defence, strategic research and marine heritage management.

The team comprises specialist archaeologists, geophysicists and geoarchaeologists. All of this team are university educated, with many holding post-graduate and doctoral degrees, and are members of an appropriate professional standards and ethics organisation. Wessex Archaeology is internationally recognised as employing leading experts in coastal and marine desk-based, geoarchaeological and geophysical assessments. Wessex Archaeology was also instrumental in the development and implementation of the Marine Aggregates Industry Protocol for Archaeological Discoveries; it furthermore administers the related website and prepares annual reports for BMAPA.

With regard to quality standards, Wessex Archaeology also operates its own in-house Quality Management System (QMS). This system has been designed to meet the requirements of the ISO 9001 standard and is regularly audited. Wessex Archaeology is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA); and fully endorses the Code of Conduct. The work for this EIA has been undertaken with reference to the CIfA's Standard and Guidance for Historic Environment Desk-based Assessment (2014, updated 2020) and wider industry best-practice.

4.4 Impact assessment methodology

To facilitate the impact assessment process, a standard analysis methodology has been applied. This framework has been developed from a range of sources, including the Marine Works (EIA) Regulations 2007 (as amended), the Town and Country Planning (EIA) Regulations 2017, statutory guidance, consultations and ABPmer's previous (extensive) EIA project experience. ABPmer has an IEMA Quality Mark, demonstrating a commitment to excellence in leading the co-ordination of statutory EIAs in the UK. This assessment has furthermore been completed in accordance with the Charted Institute of Ecology and Environmental Management's (CIEEM) latest guidelines for ecological impact assessment in the UK and Ireland which combines advice for terrestrial, freshwater and coastal environments (CIEEM, 2018).

In accordance with CIEEM (2018), an impact is defined as an action resulting in changes to an ecological feature (e.g., construction activities resulting in the direct loss of benthic habitat), and an effect is the outcome to an ecological feature from an impact (e.g., the effects on fish from the loss of benthic habitat).

The Transboundary Regulation 20 of the Marine Works (EIA) Regulations 2007 (as amended) has not been considered in the impact assessment due to the predicted localised effects of the dredging activity and the large distance between the study area and the nearest non-UK country.

The EIA considers the impacts from the entire proposed activity, covering the whole scope of the proposed dredging works. The environmental issues are divided into distinct 'receiving environments' or 'receptors'.

The effect of the proposed activity on each of these is assessed by describing, in turn: the baseline environmental conditions of each receiving environment; the 'impact pathways' by which the receptors could be affected; the significance of the impacts occurring; and the measures to mitigate for significant adverse impacts where these are predicted.

This Impact Assessment Framework, which is presented in the following sections, is designed to incorporate the key criteria and considerations without being overly prescriptive.

4.4.1 Stage 1 – Identify features and changes

The first stage identifies the potential environmental changes resulting from the proposed activity and the features of interest (receptors) that are likely to be affected (which are together referred to as the impact pathway). This aspect of the assessment has been developed in consultation with key statutory and non-statutory authorities.

The impact pathways and their potential effects which are considered relevant to the EIA are as follows:

- Draghead: the draghead removes the sediment/water mixture from the seabed. The action of the draghead leaves behind a furrow during trailer dredging, the depth of which varies depending on the compaction of the seabed sediments, the power of the dredge pump and the duration/intensity of dredging. The action of the draghead also causes noise and vibration disturbance;

- Overspill: the process of loading the dredger involves large quantities of sediment and water being pumped from the seabed into the hopper of the vessel leading to an overspill of excess water and fine sediment from the vessel's spillways. The material disperses horizontally and vertically to form a sediment plume, carried through the water by tidal flows and wave action to eventually disperse and settle onto the seabed until the sediment concentrations are reduced to background levels;
- Screening: the process used to influence the sand and gravel ratio of sediment collected by the dredger (see Section 3.4); and
- Vessel Presence: the presence of the vessel has the potential to displace other vessels and certain mobile fauna from the section of the licence area within which it is working and may also have such impacts during transit to and from a licence area. During the dredging activity, the vessel remains active and, therefore, has associated potential noise, vibration and visual impacts.

4.4.2 Stage 2 – Understand change and sensitivity

The second stage involves understanding the nature of the environmental changes to provide a benchmark against which the changes and levels of exposure can be compared. The scale of the impacts via the impact pathways depends upon a range of factors, including the following:

- Magnitude (local/strategic):
    - Spatial extent (small/large scale);
    - Duration (temporary/short/intermediate/long-term);
    - Frequency (routine/intermittent/occasional/rare);
- Reversibility;
- Probability of occurrence;
- Confidence, or certainty, in the impact prediction;
- The margins by which set values are exceeded (e.g. water quality standards);
- The importance of the receptor (e.g. protected habitats and species);
- The sensitivity of the receptor (resistance/adaptability/recoverability);
- The baseline conditions of the system; and
- Existing long-term trends and natural variability.

4.4.3 Stage 3 – Impact assessment

The likelihood of a feature being vulnerable to an impact pathway is then evaluated as a basis for assessing the level of the impact and its significance.

The key significance levels for either **beneficial** or **adverse** impacts are described as follows:

- **Insignificant**: Insignificant change not having a discernible effect;
- **Minor**: Effects tending to be discernible but tolerable;
- **Moderate**: Where these changes are adverse, they may require mitigation; and
- **Major**: Effects are highest in magnitude and reflect the high vulnerability and importance of a receptor (e.g. to nature conservation). Where these changes are adverse, they will require mitigation.

Impact assessment guidance tables

The matrices in Table 4-3 to Table 4-5 have been used to help assess significance (see below). Table 4-3 was used as a means of generating an estimate of exposure. Magnitude of change needs to be considered in spatial and temporal terms (including duration, frequency and seasonality), and against the background environmental conditions in a study area. Once a magnitude has been assessed, this should be combined with the probability of occurrence to arrive at an exposure score which can then be used for the next step of the assessment, which is detailed in Table 4-4. For example, an impact pathway with a medium magnitude of change and a high probability of occurrence would result in a medium exposure to change.

Table 4-3 Exposure to change, combining magnitude and probability of change

Probability of Occurrence	Magnitude of Change			
	Large	Medium	Small	Negligible
High	High	Medium	Low	Negligible
Medium	Medium	Medium	Low	Negligible
Low	Low	Low	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Table 4-4 was then used to score the vulnerability of the features of interest based on the sensitivity of those features and their exposure to a given change. Where the exposure and sensitivity characteristics overlap then vulnerability exists, and an adverse effect may occur.

Table 4-4 Estimation of vulnerability based on sensitivity and exposure to change

Sensitivity of Feature	Exposure to Change			
	High	Medium	Low	Negligible
High	High	High	Moderate	None
Moderate	High	Moderate	Low	None
Low	Moderate	Low	Low	None
None	None	None	None	None

For example, if the impact pathway previously assessed with a medium exposure to change acted on a receptor which had a high sensitivity, this would result in an assessment of high vulnerability. Sensitivity can be described as the intolerance of a habitat, community or individual of a species to an environmental change and essentially considers the response characteristic of the feature. Thus, if a single or combination of environmental changes is likely to elicit a response then the feature under assessment can be considered to be sensitive. Where an exposure or change occurs for which, the receptor is not sensitive, then no vulnerability can occur. Similarly, vulnerability will always be 'none' no matter how sensitive the feature is if the exposure to change had been assessed as 'negligible'.

The vulnerability was then combined with the importance of the feature of interest using Table 4-5 to generate an initial level of significance. The importance of a feature is based on its value and rarity, such as the levels of protection. For example, if a high vulnerability was previously given to a feature of low importance, an initial level of significance of minor would be given.

Table 4-5 Estimation of significance based on vulnerability and importance

Importance of Feature	Vulnerability of Feature to Impact			
	High	Moderate	Low	None
High	Major	Moderate	Minor	Insignificant
Moderate	Moderate	Moderate	Minor	Insignificant
Low	Minor	Minor	Insignificant	Insignificant
None	Insignificant	Insignificant	Insignificant	Insignificant

CIEEM correlation

The CIEEM (2018) guidelines state that an effect should be determined as being significant when it 'either supports or undermines biodiversity conservation objectives for important ecological features. It relates to the weight that should be afforded to effects when decisions are made, and to the consequences, in terms of legislation, policy and / or development control. A significant adverse effect on a feature of importance (as defined in Table 4-6) would, therefore, be likely to generate the need for mitigation.

Whilst this EIA expresses the significance of effects with reference to a geographic frame of reference (as advocated in the CIEEM Guidelines), significance is also expressed using generic EIA significance criteria. The generic criteria used throughout this report are based on an expression of severity, to describe the significance of environmental impacts. For ease of reference, Table 4-6 provides a means of relating the two approaches. To ensure transparency in the impact assessment, it is important to make clear the evidence-based or value-based judgments used at each stage of the assessment and how they have been attributed to a level of significance. This is presented in the impact assessment for each impact pathway. As shown in Table 4-6, effects that are identified as being moderate or major adverse / beneficial are classified as significant effects and those as minor or negligible as not significant.

Table 4-6 Correlation table on significance criteria – this EIA and CIEEM geographical criteria

Significance level		EIA Criteria	CIEEM Geographical Criteria
Significant	Major	These effects are likely to be important considerations at a local or district scale but, if adverse, are potential concerns to the project/activity and may become key factors in the decision-making process.	Ecological impacts assessed as being significant at the regional scale and that have triggered a response in development control terms are considered to represent impacts that overall, within this assessment, are of major significance.
	Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision-making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.	Ecological impacts assessed as being significant at the county/metropolitan scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of moderate significance.
Not significant	Minor	These effects may be raised as local issues but are unlikely to be of importance in the decision-making process. Nevertheless, they are of relevance in enhancing the subsequent design of The project/activity and Consideration of mitigation or compensation measures.	Ecological impacts assessed as being significant at the local scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of minor significance.
	Insignificant	No effect or an effect which is beneath the level of perception, within normal bounds of variation or within the margin of forecasting error.	Ecological impacts that have been assessed as not being significant at any geographic level.

4.4.4 Stage 4 – Impact management

The final stage is to identify any impacts that are found to be moderate and/or major adverse significant and require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure the use of mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e. with mitigation) identified. Please note that many mitigation measures are routinely observed by the British marine aggregates industry; these have been summarised in Section 3.5.

4.4.5 Confidence assessment

Following the significance assessment, a confidence assessment was undertaken which recognises the degree of interpretation and professional judgement applied. This is presented in the summary table contained within the conclusions section of each impact assessment section (i.e. per receptor group). Confidence was assessed on a scale incorporating three values: low, medium and high.

4.4.6 Cumulative impact and in-combination assessment

Under The Marine Works (EIA) Regulations (Amendment) 2011 it is necessary to assess the potential cumulative impacts of a proposed activity on all environmental receptors together with other known developments in the area. Under The Conservation of Habitats and Species Regulations 2010 (as amended) ('Habitats Regulations'), it is also necessary to consider the in-combination effects of a development proposal specifically on the designated features of European Sites. The EIA cumulative impact and Habitats Regulations in-combination assessments are presented in Section 19.

4.5 References

Charted Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for ecological impact assessment in the UK and Ireland (terrestrial, freshwater and coastal). CIEEM, London, 94p.

CIfA, 2014. Standard and Guidance for Historic Environment Desk-based Assessment. The Chartered Institute for Archaeologists. December 2014 (updated 2020)

ISO 9001. International Organization for Standardization. ISO/TC 176/SC 2 Quality Systems. September 2015

MarineSpace (2015) Consideration of Evidence in Respect of Defining Realistic Secondary Impact Zones in the Bristol Channel and Severn Estuary. MarineSpace, Southampton, 5p.

Tillin, H.M., Houghton, A.J., Saunders, J.E., Drabble, R. and Hull, S.C. (2011) Direct and Indirect Impacts of Aggregate Dredging. Marine Aggregate Levy Sustainability Fund (MALSF). Science Monography Series: No.1

5 Physical Processes

This section assesses the effects of the proposed dredging activity on physical processes. The first sub-section covers the data sources and consultation (Section 5.1). Section 5.2 provides a brief description of the baseline physical processes of the Bristol Channel and Severn Estuary. A summary of the North Middle Ground (NMG) and Bedwyn Sands Coastal Impact Study (CIS) methodology is given in Section 5.3. The results of the CIS are used to inform the impact assessment relating to physical processes, which is presented in Section 5.4. Section 5.5 provides a summary conclusion.

A description of the licences applied for in this ES is provided in Section 3. For the purposes of this assessment, the wider study area is defined as the region where there is a general wide-scale interaction between the coastal processes which could potentially be affected by changes in physical processes as a result of the proposed aggregate dredging. The wider study area therefore includes the Lower Severn Estuary, and the coastal frontage between Newport and the Prince of Wales Bridge (M4 road bridge) on the Welsh coast; and between Middle Hope and the Second Severn Crossing on the English coast (Figure 5-1).

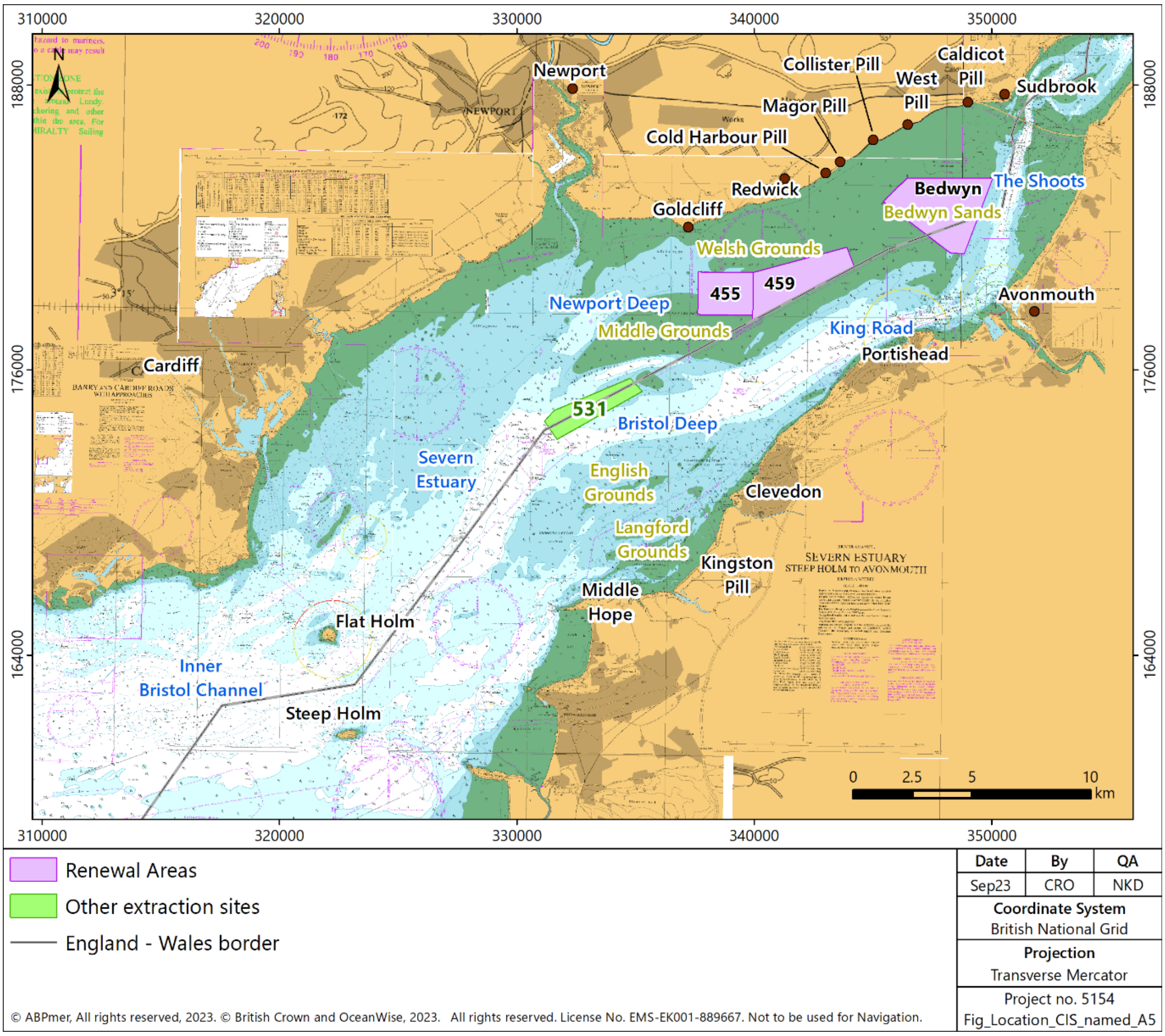


Figure 5-1 North Middle Ground and Bedwyn Sands CIS Study Area and local features

When considering the 'Source > Pathway > Receptor' model, it should be noted that the physical processes topic is often concerned with Pathways that have the potential to impact a specific receptor, rather than being concerned with the receptor itself. For example, impacts on physical processes may result in effects on pathways that subsequently impact receptors within the Benthic Ecology (Section 8) or Water and Sediment Quality (Section 6) topics.

5.1 Data sources and consultation

5.1.1 Data sources

The Physical Processes assessment has been informed by the results of the NMG and Bedwyn Sands CIS (ABPmer, 2023), and has drawn on various data sources, including:

- Output from hydrodynamic and spectral wave numerical models of the Bristol Channel and Severn Estuary (CIS; ABPmer, 2023);
- Bathymetric data sources, including a detailed bathymetric survey campaign covering the extraction areas (Shoreline Surveys, 2022), general bathymetric charts produced by the UK Hydrographic Office (UKHO), general seabed mapping produced by the British Geological Survey (BGS), and mapping of seabed and water column features provided by UK SEAMAP (JNCC, 2010);
- Hydrographic data sources, including tidal diamond velocities (UKHO, 2023), water level data from the UK National Tide Gauge Network (NTSLF), and wave buoy/radar datasets from the Channel Coastal Observatory (CCO); and
- Long-term wind statistics, derived from 40-years of hindcast data (1979 to 2022) available from the National Oceanographic and Atmospheric Administration (NOAA) National Centres for Environmental Prediction (NCEP) hindcast databases.

In addition, the principal data sources used to inform the baseline understanding are as follows:

- NMG and Bedwyn Sands Annual Monitoring data. Annual bathymetric, sedimentological and topographic monitoring data collected by Severn Sands/Breedon Aggregates as part of their ongoing monitoring activity associated with the current aggregate extraction activities on NMG and Bedwyn Sands (ABPmer, 2022a);
- Severn Estuary Shoreline Management Plan (SMP2) (Atkins, 2009 and ABPmer, 2009);
- Bedwyn Sands and NMG Annual Compliance Report (ABPmer, 2022b);
- CISs and Environmental Statements and Envi produced to accompany previous and current licence applications for Area 531, NMG and Bedwyn Sands Licence Areas (e.g. HR Wallingford, 2003a and b; ABPmer, 2015, 2016, 2019, 2023);
- Bristol Channel Marine Aggregates (BCMA) study (Posford Duvivier and ABP Research & Consultancy, 2000);
- Wave modelling study carried out on behalf of the Severn Estuary Aggregates Working Group (SEAWG, 2008); and
- Severn Estuary morphological development and sediment dynamic assessments (Jacobs, 2007; Velegrakis *et al*., 2001; McLaren and Collins, 1989).

5.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES in relation to physical processes. Individual responses to the comments received in the Scoping Opinions are provided in Appendix A.

The MMO and NRW highlighted in their respective Scoping Opinions that the impacts on wave propagation should be considered within the physical processes chapter, and that the effect of potential sediment plumes should include extent and magnitude relating to the proposed zone of influence. The assessment has been informed and supported by a range of numerical modelling studies and the outcomes are presented in the CIS (ABPmer, 2023) and summarised in this chapter.

The MMO also advised that the assessment of impacts on physical processes should not simply be an extension of monitoring and reporting under the previous (current) licence but should instead provide a comprehensive study of up-to-date and state-of-the-art knowledge.

NRW requested that a refined colour scale be used to present the resource thickness information originally included in the Scoping report. This has been updated and is presented here in Figure 3-1, supporting the assessment.

5.2 Summary of baseline understanding

The baseline characterisation of the physical processes of the Bristol Channel and Severn Estuary is summarised in this section. A more detailed description is given in the NMG and Bedwyn Sands CIS (ABPmer, 2023), which should be referred to for additional information.

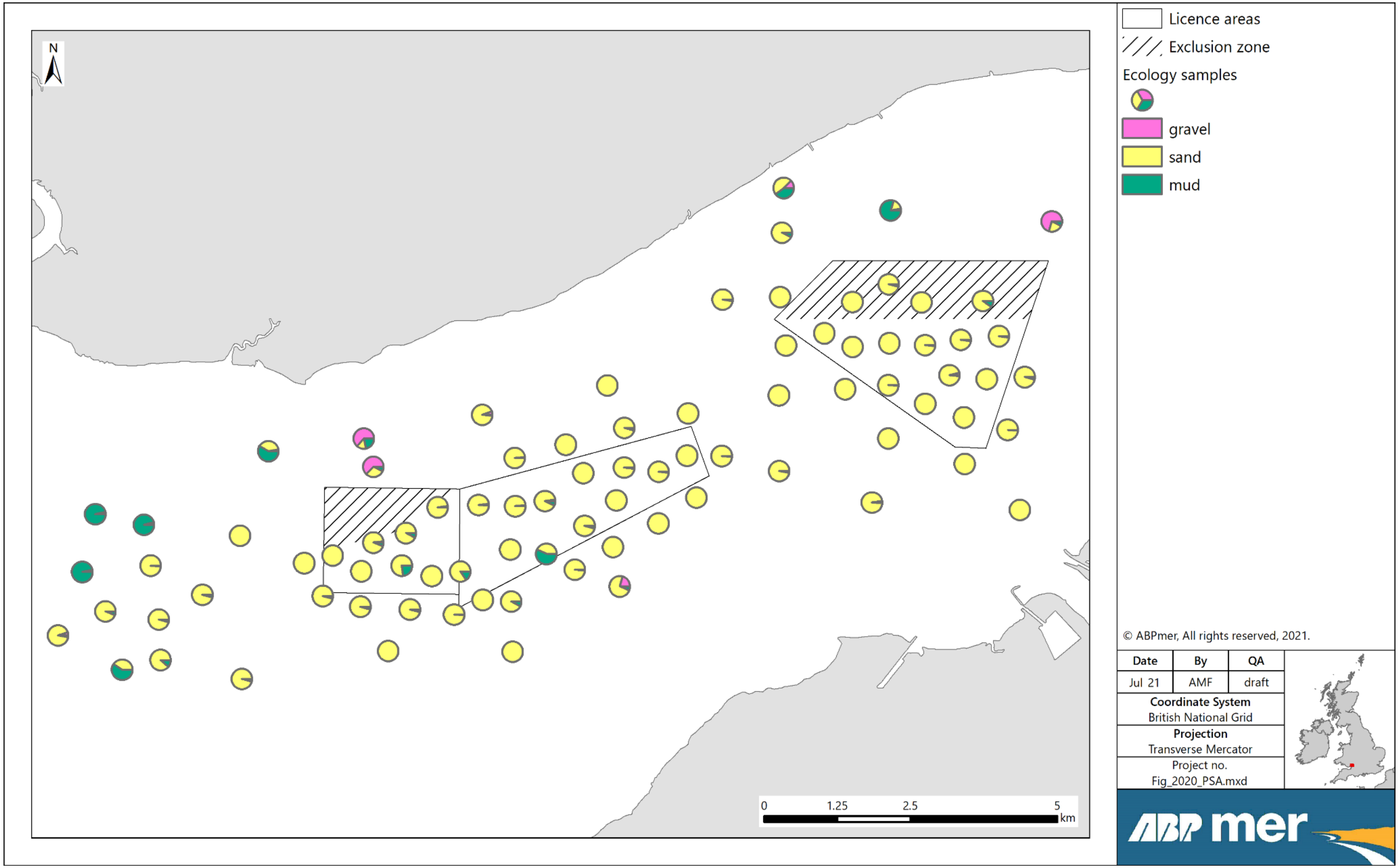
The Severn Estuary and Bristol Channel is a submarine valley system that was originally formed during the Quaternary glacial and interglacial periods (e.g. the Ipswichian interglacial around 130,000 to 115,000 years BP, and the subsequent Devensian glaciation around 115,000 to 10,000 years BP); and has been subject to ongoing modification to reach its present form (Jacobs, 2007). The primary geological units are overlain by thin veneers of glacial till and discrete areas of channel infill deposits. The largest sediment accumulations in the estuary are in the infilled river valley (in the area occupied by the Middle and Welsh Grounds) with sediment thicknesses of up to 30 m. Elsewhere, unconsolidated sediment cover in the estuary is generally thin (typically less than 5 m). Sediments are also generally well-sorted by the high energy tidal regime, leading to distinct and separate deposits of gravels, sands and muds.

The Welsh coastline, in the vicinity of the Severn Estuary aggregate extraction areas, extends approximately from Newport, in the west, to the Second Severn Crossing in the east (Figure 5-1). This coastline lies in the lee of the Middle and Welsh Grounds, when considering the dominant direction of wave approach, from the southwest. The coastline here consists of wet reedbeds, wet grasslands and shallow saline lagoons, fronted by a muddy foreshore. The frontage along the Caldicot Levels is south-easterly facing and fronted by a relatively wide expanse of intertidal saltmarsh and sandbanks. The backshore along much of this stretch is almost entirely below the level of mean high-water springs and is defended by a continuous clay embankment (example image from this section of coastline provided in Figure 5-2).

The English coastline within the study area, extends approximately from Middle Hope, in the west, to the Second Severn Crossing in the east (Figure 5-1). This coastline is a mixture of high cliffs (around Middle Hope, and between Portishead and Clevedon), along with a narrow rocky intertidal area. The coastline fronting Kingston Pill is characterised by resistant rock outcrops to the southwest and northeast, with a number of tributaries discharging into the Severn Estuary. Further upstream, the frontage between New Passage and the Old Pier at Portishead is a northwest facing embayment, and is generally fronted by intertidal mud, sand or gravel banks, saltmarsh and rock outcrops at the northern end. The docks at Avonmouth and Portishead influence the local conditions along this frontage. Sediment sizes within both extraction areas are predominantly Sand with localised gravel and mud fractions, particularly within the NMG (particle size distribution from grab samples across the study area is shown in Figure 5-3).

The Middle and Welsh Grounds form an extensive expanse of linked intertidal sandbanks and sandflats, which are laterally constrained by a series of naturally deep channels (Figure 5-1). To the west, the Newport Deep extends to a depth of around 7 m below Chart Datum (CD). To the south, the Bristol Deep and King Road extend to depths of around 18 m and 20 m below CD, respectively; whilst to the east, The Shoots extends towards the Severn Crossings, with depths approaching 30 m below CD. The shape and form of the main channel results in relatively high flow speeds, maintaining a natural flushing of these channels.

Figure 5-2 Narrow upper foreshore between Redwick and Goldcliff



Source: ABPmer, 2021a

Figure 5-3 Surface sediment classification

The Severn Estuary is subject to a very large semi-diurnal tide, of 10 to 12 m mean spring range (Table 5-1). This high tidal range is due to the combination of the North Atlantic tidal wave approaching through the Bristol Channel and the further amplification and convergence of this tidal wave as it moves into the funnel-shape of the Severn Estuary. This large and rapid rise and fall of the tide leads to very strong currents through the main body of the estuary. These strong currents maintain deep channels and high suspended sediment loads. Flows also increase in strength where they are forced through constrained narrows (e.g. The Shoots, just below the Second Severn Crossing, where the currents can exceed 6 m/s). The tidal prism (i.e. the volume of water the enters and leaves the estuary on an average tide, calculated as the difference between the tidal volume at high water and that at low water) of the Severn Estuary has been calculated at approximately 96 x 10^8 m^3 (Atkins, 2009).

Table 5-1 Astronomic tidal levels across the study area

Parameter	Astronomic Tidal Level (mCD)		
	Port Talbot (Downstream)	Newport (Adjacent)	Portburry (Avonmouth) (Upstream)
Highest Astronomic Tide (HAT)	10.7	13.6	14.7
Mean High Water Spring (MHWS)	9.7	12.3	13.2
Mean High Water Neap (MHWN)	7.3	8.9	9.8
Mean Sea Level (MSL)	5.41	6.26	6.96
Mean Low Water Neap (MLWN)	3.5	3.6	3.8
Mean Low Water Spring (MLWS)	1.1	0.8	1.0
Lowest Astronomic Tide (LAT)	0.2	-0.4	-0.1
Astronomic Tidal Range (HAT-LAT)	10.5	14.1	14.8
Spring Range (MHWS-MLWS)	8.6	11.5	12.2
Neap Range (MHWN-MLWN)	3.8	5.3	6.0

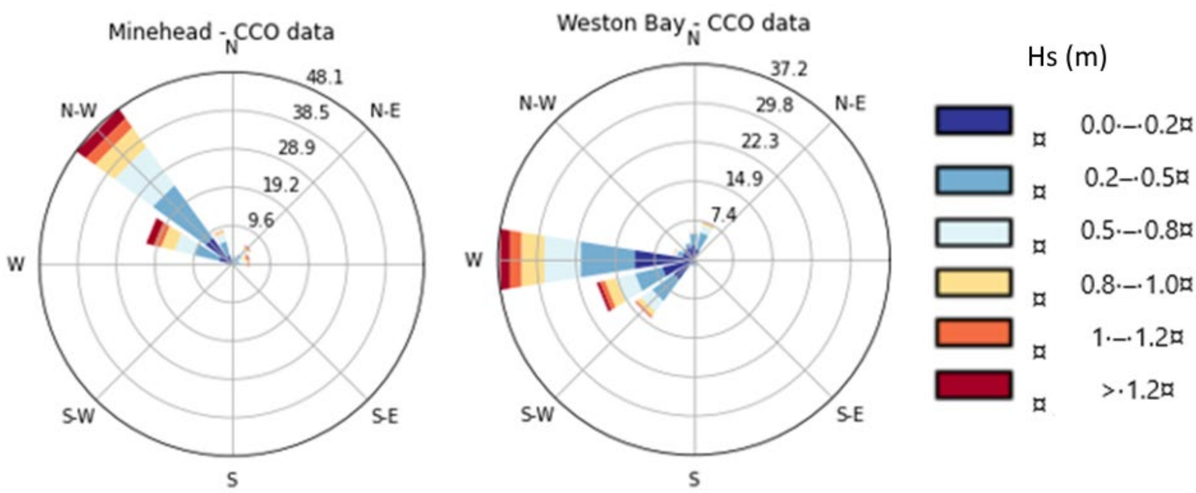
Source: UKHO, 2023

The wave climate within the Severn Estuary is considered to be mainly wind-generated, with exposure to Atlantic swell waves limited by the change in orientation of the estuary around the islands of Flat Holm and Steep Holm. The wave conditions are linked to exposure to the direction of prevailing winds and fetch distances. At high water, wave fetches can extend over long distances, whereas at low water the intertidal banks dramatically reduce fetches. Descriptive statistics of the regional wave regime are provided in Table 5-2. Sand Bay and Weston Bay, at the seaward extent of the estuary, are the upstream limit of the Atlantic-facing beaches, exposed to swell waves (Figure 5-4).

Table 5-2 Summary of measured wave data

Location	Data Start	Observed Mean Wave Parameters				
		Hs (m)	H_{max} (m)	Tp (s)	Tz (s)	Modal Peak Direction (°N)
Minehead	01/12/2006	0.56	0.90	6.9	4.0	315
Weston-Super-Mare	10/09/2009	0.42	0.66	4.9	3.2	270
Second Severn Crossing	29/06/2011	0.11	0.20	6.0	2.3	Not resolved

Source: CCO, 2023



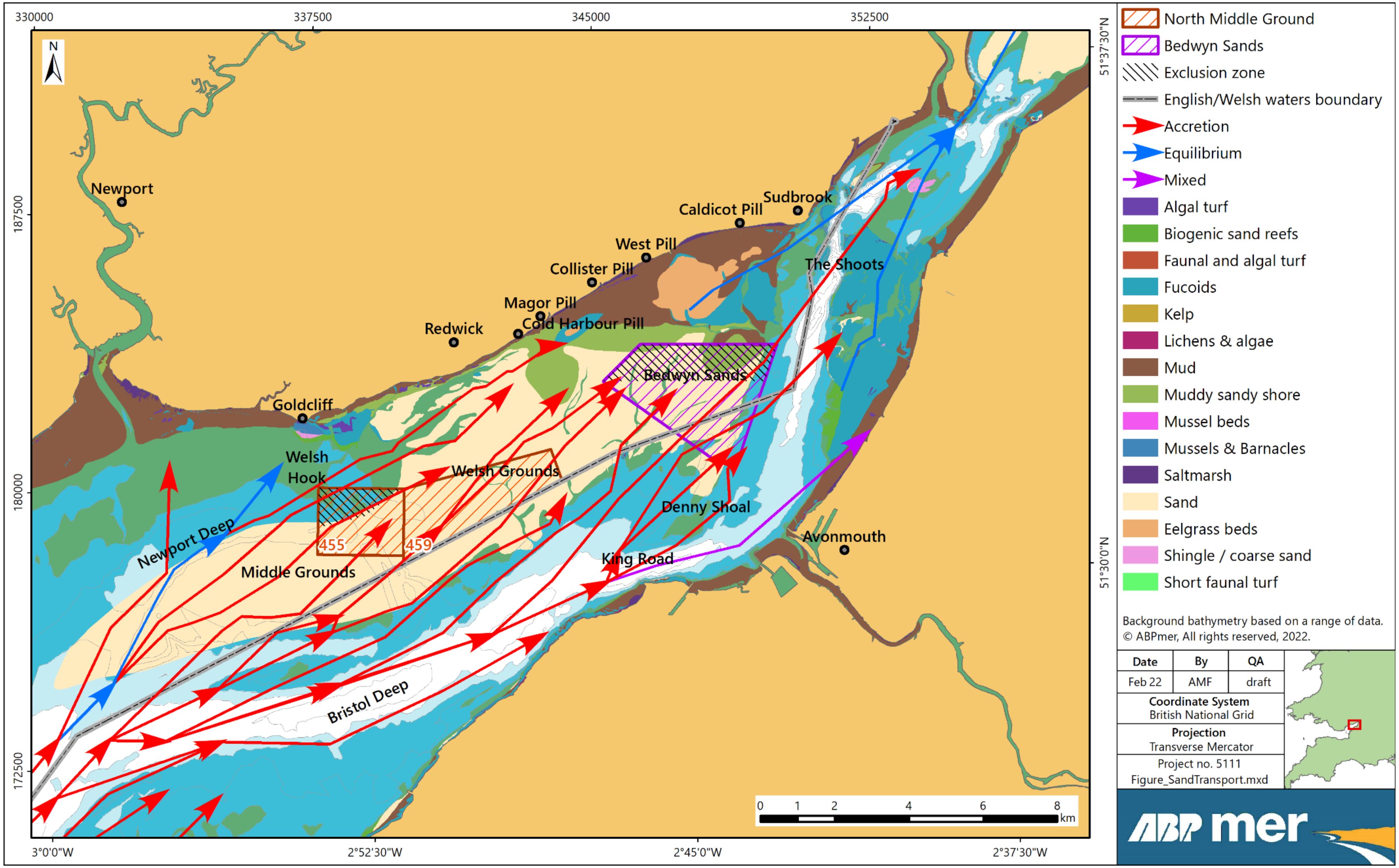
Source: CCO 2023

Figure 5-4 Wave roses for Minehead (left) and Weston-Super-Mare (right)

The bedload sediment regime within the Severn Estuary is primarily controlled by the strong tidal currents. In general, there is a net upstream transport of sands driven by the flood tide. It is considered Bedwyn Sands extraction area is towards the down-drift end of an active sand transport pathway through the Severn Estuary, a process primarily driven by the flood dominant tide, and enhanced by prevailing southwesterly winds and waves during storm conditions (Figure 5-5).

The Severn Estuary is a relatively high suspended sediment environment. Primary sources of material in suspension are from the main tributaries to the estuary - namely the Rivers Severn, Wye, Usk, Avon and Parrett - and from intertidal erosion of mudflats, due to wave action. An estuary-wide suspended sediment load of around 30 million tonnes has been defined on high spring tides, reducing to around 2 million tonnes on low neap tides. Under low-energy conditions, sediments have sufficient time to settle into fluid mud pools in the main estuary channels (e.g. Newport Deep). Primary sinks for suspended material are the sub-tidal areas fronting Bridgwater Bay (in the Inner Bristol Channel) and Newport Deep. The floodplain would also be expected to act as a major sink if this were available. However, the flood embankments (which extend along the low-lying coastlines), isolate this sink from the estuary, keeping the material within the estuarine environment and causing high concentrations.

There are no apparent sediment transport pathways for coarse material (i.e. sand and larger) between the North and Welsh Middle Grounds and the adjacent English or Welsh coastlines. Although the wide expanses of muddy foreshore (particularly along the Welsh coastline), act as a sink for fine sediments, available evidence suggests that coarser sediments across the Middle and Welsh Grounds are distinct from these. It is considered, therefore, that no pathway exists between the onshore and offshore locations, and *vice versa*.



Source: McLaren and Collins, 1989

Figure 5-5 Sand transport pathways derived from Sediment Trends Analysis

5.3 Summary of CIS methodology

Prior to presenting the impact assessment, the methodology of the CIS produced by ABPmer (ABPmer, 2023) is briefly summarised in this section. The CIS was carried out in accordance with the most recent guidance published by the British Marine Aggregate Producers Association (BMAPA), in association with The Crown Estate, MMO, Cefas and NRW (BMAPA, 2013).

The objective of the assessment was to determine how the aggregate extraction at NMG and Bedwyn Sands might impact the local and regional hydrodynamic and/ or sediment transport regime, and whether this could, in turn, adversely affect the adjacent coastlines. This was achieved by undertaking the following steps (please refer to the CIS for a comprehensive description of the methodology):

- Baseline characterisation (a summary of which has been provided in Section 5.2 above);
- Creation of pre- and post- dredging bathymetric datasets. The following datasets were created:
  - Present day (existing) baseline;
  - NMG and Bedwyn Sands post-dredging, which assumed removal of the renewed licence tonnage from both NMG and Bedwyn Sands, applied over the wider bathymetric features of the estuary; and
  - In-combination post-dredging, which includes the total licenced extraction form the adjacent Licence Area 531 alongside the NMG and Bedwyn Sands post-dredge.
- Two-dimensional hydrodynamic modelling using the MIKE21-FM-HD module, incorporating the above bathymetric datasets;
- Two-dimensional wave modelling using the MIKE21 Spectral Wave module, incorporating the above bathymetric datasets over a range of wave events including:
  - 1 in 200-year event at Mean High Water Springs (MHWS) and Mean Low Water Springs) MLWS from five direction sectors (NE, SW, W and NW);
  - 1 in 200-year event at Mean High Water Neaps (MHWN) from a south-westerly approach direction;
  - 10 in 1-year event at MHWS and MLWS from five directional sectors (NE, SW, W and NW); and
  - Climate change scenario, whereby water level, wind and wave conditions were increased in accordance with the UK Climate Projections 2018 (UKCP18) (Palmer *et al*., 2018).
- Assessment of potential impacts to sediment transport characteristics across the study area by applying desk based empirical approaches; and
- Estimation of bed shear stress values at key locations within the study area, as a result of modelled currents and waves, for both the baseline and post-dredge scenarios.

5.4 Impact assessment

The following sections considers the potential changes to the baseline conditions which may be brought about by aggregate dredging activity across NMG and Bedwyn Sands.

Impact pathways excluded from the assessment: All identified impacts pathways relating to physical processes have been taken forward in this assessment.

Impact pathways included in the assessment: The key impact pathways relating to physical processes are the following:

- Effects on the English and Welsh coastlines due to changes in wave height and tidal currents (Section 5.4.1);

- Effects on the English and Welsh coastlines due to beach 'draw-down' of material into the dredged areas (Section 5.4.2);
- Effects on the English and Welsh coastlines due to changes in sediment transport pathways (Section 5.4.3);
- Effects on the wider system of sandbanks within the Severn Estuary Special Area of Conservation (SAC), due to changes in bedload sediment transport and wave and tidal induced seabed mobility (Section 5.4.4); and
- Cumulative effects on the coast with ongoing dredging with Licence Area 531, NMG and Bedwyn Sands (Section 5.4.5).

The following sections describe the general scientific context associated with each of these potential impact pathways, together with a summary of the CIS conclusions, and an assessment of the impact from the proposed aggregate dredging across NMG and Bedwyn Sands. Full detail of the predicted impacts, along with figures showing the magnitude and extent of the likely effects, are provided in the CIS (ABPmer, 2023).

5.4.1 Effects on the coastline due to changes in wave height and tidal currents

General scientific context and summary of CIS conclusions

Dredging activity results in a lowering of the bed over the extraction area. Where this dredge is relatively deep, or where recovery times are long, such bed lowering has the potential to affect tidal currents over the site. The CIS (ABPmer, 2023) predicted relatively small changes to flood and ebb tidal currents which are principally confined to within 3 km of the extraction area boundaries. Across the study area, the predicted magnitude of change is largely less than ±0.05 m/s (<6% of baseline flows) in peak current speed and less than 2° shift in current direction. No change is predicted to the existing (baseline) tidal asymmetry, following the proposed extraction of the renewal volumes.

The predicted changes to the extreme wave heights (1:200 year) are also small in magnitude, and although they extend slightly beyond the boundaries of the licence areas (notably under MLWS conditions), they do not impact either the English or Welsh coastlines under any of the wave conditions assessed. The magnitude and extent of predicted effects is greatest for waves approaching from the southwest and coinciding with MHWN. Extraction is predicted to generate increased wave heights of up to 0.14 m (~6% baseline) in NMG and of up to 0.05 m (1-2% baseline) in Bedwyn Sands. Changes in direction of less than 2° are predicted for waves approaching from the southwest. Predicted changes to the wave regime from the range of other directions assessed within the CIS are lower in magnitude and smaller in extent. Under MLWS conditions, the predicted effects on wave conditions are greatly limited in extent by the drying intertidal sandbanks. The predicted effects on a more typical (10 in 1-year) wave, under both MHWS and MLWS elevations, are reduced in extent and magnitude compared to the extreme wave event assessments.

Impact assessment

Predicted changes to current speeds and wave heights, as a result of the conservative extraction scenario assessed, are generally constrained to within the extraction areas and are of small magnitude in both relative and absolute terms. Given the dynamic nature of the Severn Estuary, it is considered that the changes predicted would not be measurable within the range of natural variability. On this basis, it is concluded that there is no risk from the predicted changes to the tidal current speed/direction, 1:200-year wave height, or from energy focussing along sensitive coastlines.

As a result, the magnitude of change and probability of occurrence at the coastline are both assessed as negligible, and the associated impact is assessed as **insignificant**. The extreme wave is also an infrequent event that is unlikely to affect the net long-term transport pathways. As a result, it is considered that both littoral transport (along the English and Welsh coasts), and sand transport within, and upstream of, the Middle and Welsh Grounds, would not be affected by the proposed renewal of the ongoing extraction activity.

5.4.2 Reduction in beach volume from 'draw-down' of material into the dredged areas

General scientific context and summary of CIS conclusions

Beach draw-down is a beach response to variations in the local wave climate. If dredging is carried out too close to the shoreline, there is potential for some beach material to be drawn down into the dredged depressions under wave action, where it may become, permanently or temporarily, trapped. The seaward limit of offshore movement during this process, and the depth from which sediment can subsequently return to the beach, depends on several factors such as the severity of the wave climate, the nature of the beach material itself, as well as the nearshore seabed topography.

As described above, the predicted changes to tidal flows and wave conditions, as a result of the conservative extraction scenario assessed, are generally small in magnitude and limited in extent to the vicinity of the dredged areas.

Throughout the central part of the Severn Estuary, there is a clear delineation between the upper foreshore, which is characterised by fine sediments, and the lower foreshore and shallow subtidal, which is largely composed of sand across the Middle and Welsh Grounds sandbank features. The cohesive, fine material of the foreshore is transported throughout the estuary in suspension, rather than as bedload. Therefore, it is very rarely drawn down onto the offshore sandbanks.

Furthermore, the NMG and Bedwyn Sands dredge locations are separated from the English shoreline by the primary Bristol Deep navigation channel. NMG can similarly be considered separated from the Welsh coastline by the Newport Deep channel. As such, the fine material contained within the muddy foreshore regions is not directly linked to either of the extraction areas, nor is there a possibility of movement under gravity, since the presence of the channels would require upwards flow onto the sandbank. No significant channel exists between the Bedwyn Sands extraction site and the Welsh shoreline. However, previous studies on sediment transport pathways (McLaren and Collins, 1989) concluded that there is no sediment transfer between Bedwyn Sands and the shoreline along the Caldicot Levels, meaning that the removal of aggregates at Bedwyn Sands is not considered likely to have any impact on beach levels along the Welsh coastline. Ongoing annual monitoring of both offshore bathymetry and foreshore topography, associated with the existing extraction activities from both sites corroborates this, revealing no impact on the Welsh foreshore as a result of current aggregate extraction activities.

Impact assessment

As a result of minimal predicted changes in wave and tidal conditions at the coast, sediment compositions, seabed topography and previous monitoring of the extraction areas, it is concluded that there is minimal risk of beach draw-down into dredged depressions across NMG and Bedwyn Sands being observed along the adjacent English and Welsh coastlines. As a result, the magnitude of change and probability of occurrence are both assessed as negligible, and associated impact is assessed as **insignificant**.

5.4.3 Effects on the coastline due to changes in sediment transport pathways

General scientific context and summary of CIS conclusions

The CIS indicates that, as a result of predicted changes to tidal currents, bed shear stress (BSS) is reduced by up to 0.8 N/m^2 (~30%) at the edges of the dredge areas. At these locations, the side slopes resulting from material removal tend to result in the greatest predicted changes in peak flow speed and associated BSS. Across the wider study area, maximum predicted changes to BSS are generally below ±0.2 N/m^2. This change in BSS equates to a relative change of less than ±10% of baseline values for the majority of points reviewed. Comparison of pre- and post-dredge conditions with thresholds of mobility for sediment particles show locations across the wider region typically exhibit a negligible effect on the exceedance of the defined thresholds.

Under all wave conditions, within the dredge areas of NMG and Bedwyn Sands, there are small variations in the predicted changes to the existing (baseline) BSS as a result of the proposed extraction. The largest changes are predicted at the edges of the extraction areas for southwesterly wave events during MHWS conditions, where reductions of approximately 0.1-0.2 N/m^2 are predicted. These reductions are attributed to the locally increased water depth, meaning waves exert less of an influence on the bed. Comparison with thresholds for sediment mobility shows that the movement potential of medium sand (the predominant sediment across much of the area) is not affected by the predicted changes to wave-induced BSS within the extraction area. Elsewhere, predicted changes to wave induced BSS are typically < ±2%. Analysis stations along the English and Welsh coastlines indicate no change in wave-induced BSS for either the extreme (1 in 200) or morphological (10 in 1) wave events.

The baseline characterisation identified that the offshore sandbank/sand flat features are not a contemporary source of material and that there are no sediment transport linkages between the wider Middle and Welsh Grounds and the adjacent coastlines (ABPmer, 2023).

Impact assessment

The assessment of wave- and tidal-induced sediment mobility demonstrates that any changes to sediment movement will be small and confined to the extraction areas and the immediate vicinity. The predicted changes across the wider study area are considered negligible and do not impact the mobility potential of the range of material found across the study area. It is, therefore, considered that the proposed renewal of aggregate extraction within these areas will not result in any associated change in sediment transport patterns or seabed morphology across the wider study area, or along either the English or Welsh coasts. As a result, the magnitude of change and probability of occurrence are both assessed as negligible, and the associated impact is assessed as **insignificant**.

5.4.4 Effects on bedforms and the wider system of sandbank features across the wider study area

General scientific context and summary of CIS conclusions

The proposed renewal of extraction within NMG and Bedwyn Sands, along with the existing Licence at Area 531, is located within the designated Severn Estuary SAC. The Severn Estuary SAC is characterised by a number of intertidal sandbank and sand flat features, bounded by relatively deep channels.

There will be a continuation of direct effects on the intertidal sand resources from the renewal of the currently licenced activities. Dredging for aggregate extraction has a direct effect on these bedforms as a result of the movement of the dredger over the surface, and the associated extraction of the sand material. This activity is limited in both magnitude (dredging of shallow furrows in the seabed) and extent (within the NMG and Bedwyn Sands Licence Renewal Areas).

The NMG and Bedwyn Sands CIS (ABPmer, 2023) has also assessed the potential wider, indirect effects on the sand transport pathways linking the seabed features throughout the study area. Existing sediment transport pathways indicate that sand material is transported up-estuary, driven by the dominant flood tide, and enhanced by intermittent south-westerly storm activity. The defined transport pathways extend over the wider Middle and Welsh Grounds, across to the English coastline, and then onwards, past the Severn crossings, to the upper estuary. The pathways extend across the full width of the Middle and Welsh Grounds, with material transported through, and to both the north and south of, the existing extraction areas (McLaren and Collins, 1989).

The assessment of pre- and post-dredge tidal currents and waves show change will be small in magnitude and localised to the deepened assessment areas within NMG and Bedwyn Sands. The associated effects on sediment transport are also small in magnitude and similarly localised to the deepened extraction areas. There is unlikely to be any change to the general easterly-directed sediment transport pathways, the primary drivers of bedload transport.

As part of the licence conditions for both sites, monitoring of the aggregate resource has been ongoing since extraction began at Bedwyn Sands in 2008 (ABPmer 2022b). This monitoring has identified a variable pattern of change with some years showing increases against baseline metrics and others showing reductions. Overall, none of the assessment metrics have flagged any issues of concern and none of the triggers for further monitoring (or, indeed, adjustments to extraction) have been met. Throughout the monitoring period, no changes outside of the natural variability of the wider system have been observed.

Impact assessment

The proposed renewal of the existing extraction licences from the NMG and Bedwyn Sands areas will continue to have limited effect on the sand transport pathways across the wider region. The defined sand transport to the Middle and Welsh Grounds will be maintained, as will the onward transport of material into up-estuary areas, and to the associated bed features therein. Any changes will be highly localised to the assessment area around the existing extraction locations and, given the baseline characterisation regarding the dynamic nature of these sandbank features, any such change is likely to be within the range of natural variability. There is not considered to be any significant effect on the sandbank features within the wider SAC. As a result, the magnitude of change and probability of occurrence are both assessed as negligible, and associated impact is assessed as **insignificant**.

5.4.5 Cumulative effects on the coast with ongoing dredging in other sites within the study area

General scientific context and summary of CIS conclusions

Part of the assessment undertaken within the NMG and Bedwyn Sands CIS (ABPmer, 2023) has assumed a conservative, cumulative removal of material across NMG, Bedwyn Sands and the existing Licence Area 531.

The effects of cumulative aggregate extraction on tidal currents are limited in extent to the deepened areas. In and around NMG and Bedwyn Sands, the pattern and magnitudes of changes to flow speed and direction are very similar to those predicted for extraction from these sites in isolation. There is no evidence of effects from the different extraction areas combining to cause increased impacts on peak flow speeds.

The results of the cumulative assessment on the extreme wave conditions (1 in 200-year) remain consistent with those derived from consideration of extraction in NMG and Bedwyn Sands only. The greatest predicted effects are shown under south-westerly wave approach directions during MHWS, with the largest increase in wave height (up to 0.03 m) limited to the deepened dredge areas. Area 531 is simulated to generate a localised reduction in wave heights in the northern end of the dredge area by up to 0.04 m, caused by steeper shoaling of waves and increased breaking, associated with bed slope. The impact of this dredge, however, does not interact with the predicted changes associated with NMG and Bedwyn Sands. Under MLWS conditions, the predicted effects on wave conditions are greatly limited in extent by the drying intertidal sandbanks. The predicted cumulative effects on a more typical (10 in 1-year) wave, under both MHWS and MLWS elevations, are reduced in extent and magnitude compared to the extreme wave event assessments.

The predicted cumulative effects on the tidal and wave conditions are similar in magnitude to those predicted for the assessment of NMG and Bedwyn Sands in isolation. Accordingly, the associated changes to BSS, and resultant seabed mobility, also remain similar. As a result, the predicted effect on sediment mobility (and the wider sand transport pathways) is likely to be small in magnitude and limited in extent to the individual extraction areas.

The results of the ongoing monitoring reveal the range of variability in the elevation and area of the wider Middle and Welsh Grounds sandbank system. During the monitoring period, aggregate extraction has also been carried out at downstream licence Area 531. As a result, the observed changes in the sandbank system can be reasonably assumed to reflect impacts arising from the cumulative extraction activity at each of the presently licenced Severn Estuary extraction sites. Throughout the monitoring period, no changes outside of the natural variability of the wider system have been observed.

Impact assessment

The proposed extraction from NMG and Bedwyn Sands combined with that from Area 531 is not predicted to significantly change tidal current speed/direction, extreme wave heights, typical wave heights or sand transport pathways. There is no evidence of effects from the different extraction areas combining to cause increased impacts across the wider area. As a result, the assessment of a conservative, worst case removal scenario provides a magnitude of change and probability of occurrence that are both assessed as negligible, and the associated cumulative impact is assessed as **insignificant**.

5.5 Summary and conclusions

Table 5-3 summarises the impact assessment judgements, presents final conclusions on overall impacts across all impact pathways, and provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and, finally, significance are assessed.

Table 5-3 Physical processes impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Both probability of occurrence and magnitude of change have been assessed as negligible for each physical process impact pathway. Consequently, the exposure to change of each is also assessed as negligible.
Estimation of vulnerability	Irrespective of the sensitivity of the feature, the assessment of exposure to change as negligible results in the estimation of vulnerability of the physical process impact pathways assessed as none.

Assessment	Summary
Estimation of significance	Irrespective of the importance of the feature (which is generally assumed to be high for all features), the assessment of vulnerability as none results in the estimation of significance of the physical impact pathways being insignificant. Ongoing continuation of the existing monitoring campaign is proposed.
Conclusion	Overall, it is considered highly unlikely that the continued extraction of aggregates from NMG and Bedwyn Sands will result in any significant effect on the physical processes of the wider study area (i.e. impacts will be **insignificant**); this also applies to cumulative extraction scenarios, considering removal of material from already licensed sites (Area 531) across the wider region.
Confidence Assessment	The Severn Estuary has been the subject of a large number, and wide range, of studies. As a result, the hydrodynamic and sedimentological processes are well understood. Furthermore, the ongoing aggregate extraction activity, both within NMG and Bedwyn Sands Licence Areas and across the wider study area, provides up to date and relevant data with which to assess the effects of such activity. As a result, a high confidence can be placed in the assessment of physical processes effects.

5.6 References

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6 Water and Sediment Quality

This section assesses the effects of the proposed aggregate extraction in Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on water and sediment quality receptors. Section 6.1 outlines the data sources and consultation used to inform the baseline and assessment. Sections 6.2 and 6.3 cover the baseline and impact assessment relating to water and sediment quality, respectively and Section 6.4 provides a brief conclusion.

A definition of the study area applied within this ES is provided in Section 4.1. For the purposes of this water and sediment quality assessment, the wider study area encompasses the Severn Estuary and Bristol Channel.

6.1 Data sources and consultation

6.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- Bedwyn Sands and North Middle Ground 5-year Substantive Review (ABPmer, 2022);
- Environment Agency Bathing Water Data Explorer (Environment Agency, 2023a);
- NRW's Water Watch Wales Data Explorer (NRW, 2023);
- Environment Agency Catchment Data Explorer (Environment Agency, 2023b);
- Environment Agency Clearing the Waters for All guidance (Environment Agency, 2016);
- Environment Agency Water Quality Data Archive (Environment Agency, 2023c);
- Severn Tidal Power - Strategic Environmental Assessment (SEA) Topic Paper: Marine Water Quality (Department of Energy and Climate Change (DECC), 2010); and
- Charting Progress 2 (UK Marine Monitoring and Assessment Strategy Community (UKMMAS), 2010).

6.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES in relation to water and sediment quality. Individual responses to the comments received in the Scoping Opinions are provided in Appendix A.

The MMO and NRW highlighted in their respective Scoping Opinions that the impacts of potential sediment plumes should include extent and magnitude of potential sediment plumes relating to the proposed zone of influence. The assessment has been informed and supported by a range of numerical modelling studies and the outcomes are presented in this chapter.

The MMO also advised that information on the sediment quality and potential for any effects on water quality through suspension of contaminated sediments should be considered in the ES. The existing sediment quality and potential impacts on water quality are reviewed and assessed in this chapter. The consequences to other relevant receptors (e.g. fish) are considered in other topic assessment chapters.

NRW requested that the most up to date classification for the Severn Water Body should be used in the ES. The latest available information from Water Watch Wales has been used to support the assessment presented in this chapter and the WFD Compliance Assessment (Appendix D).

6.2 Review of baseline understanding

6.2.1 Water quality

Many standards for water quality are regulated at European Union (EU) level through a range of environmental directives, however these have since been transposed into UK law by the European Union Withdrawal Act 2018. The most relevant for the Bedwyn Sands and NMG Licence Renewal Areas include the following:

- Water Framework Directive (WFD) (2000/60/EC), implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017;
- Bathing Waters Directive (76/160/EEC and 2006/7/EC)), implemented in the UK under the Bathing Water Regulations 2013 (as amended);
- Priority Substances Directive (2008/105/EC), transposed into UK law by The Water Framework Regulations;
- Shellfish Waters Directive (79/923/EEC and 2006/113/EC) (now repealed and subsumed within the WFD Regulations);
- Nitrates Directive (91/676/EEC), implemented in the UK under the Nitrate Pollution Prevention Regulations 2015 (as amended);
- Urban Wastewater Treatment Directive (91/271/EEC), implemented in the UK through the Urban Wastewater Treatment Regulations 1994 (as amended); and
- Marine Strategy Framework Directive (MSFD) (2008/56/EC), implemented by the UK Marine Strategy Regulations 2010.

In particular, the WFD (2000/60/EEC) established a framework for the management and protection of Europe's water resources. It was implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017, known as the Water Framework or WFD Regulations.

The Environment Agency published River Basin Management Plans (RBMPs), which set out measures through which compliance with WFD objectives will be achieved. The proposed activities are located within the Severn River Basin District (Environment Agency, 2022), and overlap the Welsh Severn Lower transitional water body (ID: GB530905415401). As summarised by NRW (2023), the Severn Lower transitional water body is classified as a heavily modified water body (HMWB). This means 'ecological potential' is applied rather than 'ecological status'. The current (2021) overall status of the water body is 'moderate', based on 'moderate' ecological potential and 'moderate' chemical status (NRW, 2023). The reason for the 'moderate' ecological potential is based on biological quality elements 'invertebrates' and 'angiosperms' (saltmarsh), and the supporting element 'mitigation measures assessment'. The 'moderate' chemical status is based on the priority hazardous substance 'mercury and its compounds'.

With respect to Welsh water bodies, the Wye (ID: GB530905415406) and Usk (ID: GB530905415404) transitional water bodies all flow into the Severn Lower transitional water body. Each of these water bodies have a current (2021) overall status of 'moderate', with a 'moderate' ecological potential and 'high' chemical status (NRW, 2023). The Severn Middle (ID: GB530905415402) and Bristol Avon (ID: GB530905415405) water bodies also flow into the into the Severn Lower transitional water body. Each of these have a 'moderate' ecological potential (based on the 2022 classification), and a chemical status of 'fail' (based on the 2019 classification, noting that the 2022 classification 'does not require assessment') (Environment Agency, 2023b).

Temperature and salinity

The Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site (51.516°N, 2.704°W), located approximately 2 km upstream from Bedwyn Sands and 15 km from NMG, provides periodic water temperature records, spanning 2013 to 2023. There is a seasonal trend in water temperature at this site, with maximum water temperatures observed in the summer (20.5ºC August 2019) and minimum water temperatures in the winter (4.5ºC February 2018) (Environment Agency, 2023c). Summer water temperatures are generally greater than 13°C in the Bristol Channel (Elliott and Clarke, 1991), reaching ~18°C in the upper reaches of the Estuary (DECC, 2010). Water temperatures in winter range between 4 and 8°C in the Severn Estuary, with the lower temperatures reported in the upper reaches of the Estuary (DECC 2010).

Due to the high tidal flows and shallow waters of the Severn Estuary, the water column is relatively well mixed. There is a noticeable salinity gradient between the north (Wales) and south (England) coastlines along the length of Severn. This is a result of increased freshwater inputs from Welsh rivers, as well as the way in which the tidal flows propagate through the Estuary, leading to reduced salinities along the Welsh coast. There are 19 estuarine systems that enter the northern coastline of the Severn Estuary and Bristol Channel, including the River Severn itself, and seven along the southern coastline (Uncles, 2010). Salinity measurements are around 28 to 32 psu in the lower reaches of Estuary, characteristic of seawater. Within the main body of the estuary, typical variations between 24 to 28 psu have been reported, and upstream, salinity gradually reduces further (DECC, 2010). A seasonal trend in salinity values is observed at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site, with lower values in winter suggesting increased freshwater inputs in the winter/spring months, and the highest salinity values in late summer/autumn (Table 6-1).

Table 6-1 Temperature and salinity values collected from 'Severn Estuary EQS monitor off KWR at high water' site between 2019-2023

Month and Year	Temperature of Water (°C)	Salinity (ppt)
September 2019	17.5	25.62
October 2019	15.5	23.72
November 2019	9.6	13
December 2019	6.9	14.6
February 2020	7	16.74
March 2020	6.9	9.65
May 2021	11.8	24.88
May 2023	13.04	25.485
June 2023	18.8	25.11
August 2023	18.3	25.3

Source: Contains Environment Agency information © Environment Agency and database right

Dissolved oxygen

Dissolved oxygen in water is essential for the survival of aquatic organisms (plants and animals), and concentrations provide an indication of the health of a particular waterbody. Therefore, a reduction in dissolved oxygen concentrations, due to an increased biological consumption (e.g. eutrophication) or other natural processes, can dramatically affect the functioning of marine ecosystems. Low dissolved oxygen concentrations have been well documented in several UK estuaries in the past, although investment in wastewater treatment over a number of decades has substantially addressed the issue.

Owens (1984) reported reduced dissolved oxygen saturation in the upper Severn Estuary (upstream of Bedwyn Sands and NMG), particularly during summer conditions of low flow and high temperature. However, dissolved oxygen concentrations in the Severn Estuary are typically high. In 2004 and 2005, surface water dissolved oxygen concentrations above 8 mg/l were reported throughout the Estuary in monitoring samples collected by the Environment Agency (DECC, 2010).

Dissolved oxygen concentrations recorded at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2019 and 2023 suggest a seasonal trend, with maximum concentrations in the winter and minimum concentrations in the summer (high biological oxygen demand; see Table 6-2. There was no apparent trend in oxygen saturation during this period, although values were consistently above 85%. As of 2019, dissolved oxygen in the Severn Lower transitional waterbody was categorised as high with 'Very Certain' confidence (NRW, 2023).

Table 6-2 Mean monthly oxygen saturation (%;) and dissolved oxygen concentration (mg/l;) from the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2019 and 2023

Month and Year	Oxygen Saturation (%)	Dissolved Oxygen (mg/l)
September 2019	92.3	7.6
October 2019	87.7	7.61
November 2019	87.8	9.26
December 2019	86.5	9.63
February 2020	92.9	10.2
March 2020	94.8	10.9
May 2021	94	8.76
May 2023	87.4	7.89
June 2023	96.3	7.76
August 2023	96.9	7.87

Source: Contains Environment Agency information © Environment Agency and database right

Suspended sediment

The high tidal flows and muddy sediments lead to highly turbid conditions in the Estuary (Langston *et al*., 2003, Manning *et al.,* 2010). Primary sources of material in suspension are from the main tributaries to the Estuary, namely the Rivers Severn, Wye, Usk, Avon and Parrett, and from intertidal erosion of mudflats, due to wave action.

The most comprehensive survey of suspended sediment loads across the estuary was undertaken between 1974 and 1978, consisting of multiple cross-estuary transects, which were sampled throughout the tidal cycle. Close to 2,500 profiles were assessed in total. The main findings were of an estuary with high regional turbidity, and a cycling of suspended material over semi-diurnal (ebb and flood) and semi-lunar (spring-neap) timescales, between the water column and the seabed. Sampling indicated an estuary-wide suspended sediment load of around 30 million tonnes on high spring tides, reducing to around 2 million tonnes on low neap tides (Kirby, 1986). Under low-energy conditions, sediments have sufficient time to settle into fluid mud pools in the main estuary channels (e.g. Newport Deep). Primary sinks for suspended material are the sub-tidal areas fronting Bridgwater Bay (in the Inner Bristol Channel) and Newport Deep.

Typically, concentrations in the outer Bristol Channel are <10 mg/l, around 50 mg/l in the Inner Bristol Channel and progressively increase into the lower Severn Estuary to >500 mg/l on occasions (Kirby, 1986; 2010). It should be noted that inputs of suspended material to the water column from tidal re-suspension greatly outweigh anthropogenic inputs (DECC, 2010). In the upper reaches of the Severn Estuary, concentrations of suspended particulate matter can be >10 g/l for river flows up to 50 m^3/s, rising to over 50 g/l during periods of lower river flow (Manning *et al*., 2010).

Based on Environment Agency data, median suspended sediment values along the length of the Severn Estuary ranged from 81 to 336 mg/l. Within an estuary, the concentration of suspended sediments often develops a maximum where fluxes from rivers and the action of tides and density driven currents converge. This maximum is known as the Estuarine Turbidity Maximum (ETM). For the Severn Estuary, the ETM occurs within the mid estuary region, extending from Sharpness to Watchet (Langston *et al.*, 2003; Kirby *et al.*, 2004; DECC, 2010); a spatial range that incorporates the Middle and Welsh Grounds, NMG, Bedwyn Sands and Area 531.

Suspended sediment concentrations can present discrete variations in vertical, lateral and longitudinal planes within the Severn Estuary (Kirby, 2010). Concentrations can vary markedly in the vertical, with extremely high concentrations within near bed layers, often >20,000 mg/l (DECC, 2010). The reduction in flow rate between spring and neap tides leads to an increased settling of suspended sediment, which subsequently becomes re-suspended on the next spring tide cycle (Kirby, 1986; Kirby *et al.*, 2004, DECC, 2010).

Nutrients

Riverine inputs provide the primary source of nutrients to the Severn Estuary and Bristol Channel (inorganic nitrogen, phosphate and silicate), largely through agricultural run-off (e.g. fertilisers and other products rich in nitrogen and/or phosphorus) and urban wastewater discharge outfalls. The availability of nutrients is essential to support aquatic life, although excessive levels can lead to eutrophication. Eutrophication is defined by the Urban Waste Water Treatment Directive (91/271/EEC) as "*the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned*".

Relatively high loads of total oxidised nitrogen enter the marine environment via the Severn Estuary (Nedwell *et al.*, 2002; cited in Marine Environment Monitoring Group (MEMG), 2004). The total cumulative flux of inorganic nitrogen (nitrites, nitrates, ammonia) to the Bristol Channel, including those transferred through the Severn Estuary, was estimated to be 167 tonnes per day for the period 2000 to 2003 (Jonas and Millward, 2010).

Two areas along the southern Welsh coastline have recently been identified as problem areas for eutrophication, specifically the Tawe and Loughor Estuaries (NRW, 2017). Historically, these two areas, as well as Cardiff Bay, have been highlighted as problem areas (OSPAR Commission, 2008; 2009; Department for Environment, Food and Rural Affairs (Defra), 2012). The Tawe and Loughor Estuaries are both located more than 50 km downstream of the Bedwyn Sands and NMG Licence Renewal Areas. However, measures are in place to address these problem areas, including the improvement of sewage collection and wastewater treatment systems which will reduce the potential for eutrophication. Furthermore, the highly turbid properties of waters in the Severn Estuary enable minimal light penetration and, thus, algal growth and eutrophication are not considered a major issue (DECC, 2010).

Within the Severn, South West and Western Wales RBMPs, the following coastal and transitional water bodies have been assessed as being at good status (Figure 6-1) in respect of dissolved inorganic nitrogen (supporting biological quality element):

- Severn Lower (transitional);
- Severn Middle (transitional); and
- Bristol Channel Inner South (coastal) (NRW, 2023, Environment Agency, 2023b).

Both Bristol Channel Inner North and Bristol Channel Outer North (coastal) are assessed as being at moderate status in respect of dissolved inorganic nitrogen.

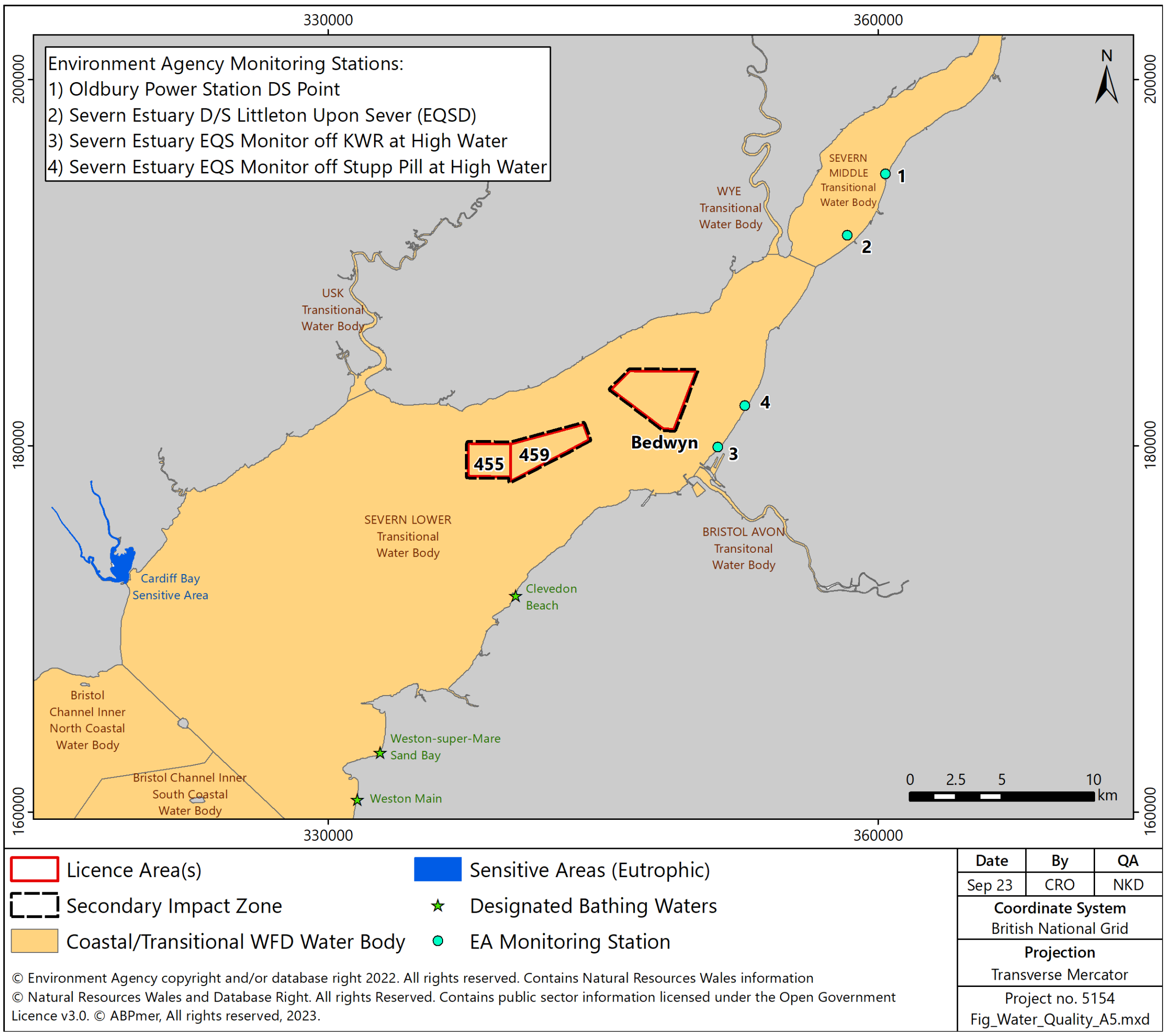

Figure 6-1 Coastal and transitional water bodies in the study area

The concentration of phosphate in freshwater inputs to the Severn Estuary varies seasonally. In summer, dissolved concentrations range from 0.6 to 0.05 mg/l, depending on whether the sample is taken from fresh or more saline (32 psu) waters, respectively. Similarly, concentrations of phosphate range from 0.3 to 0.1 mg/l in winter (DECC, 2010). In transitional and coastal waters, dissolved inorganic nitrogen is usually the limiting factor in algal growth, and phosphate inputs do not give rise to eutrophication.

Bathing waters

Under the Bathing Water Regulations, bathing waters are classified as excellent, good, sufficient or poor, according to the levels of certain types of bacteria (intestinal enterococci and *Escherichia coli*) in samples obtained during the bathing season (May to September) (see Appendix D for more details).

Table 6-3 and Table 6-4 present water quality classification for English and Welsh bathing waters within 40 km of the Licence Renewal Areas. The nearest coastal bathing water to the Licence Renewal Areas is Clevedon Beach in England (6.8 km to the south west), for which good water quality is reported for the period 2018 to 2022. Similarly, the nearest bathing water in Wales, Jackson's Bay Barry Island (28.0 km to the south west), was classified as good in 2019 but sufficient between 2020 and 2022. Burnham Jetty in England (30 km to the southwest) is the only nearby bathing water which has failed the minimum required standards of the Bathing Water Regulations (poor rating) (Table 6-3).

Table 6-3 Bathing water quality of nearby bathing waters in England

Bathing Water	Distance (km)	Year			
		2018	2019	2021	2022
England					
Clevedon Beach	6.8	Good	Good	Good	Good
Weston-Super-Mare Sand Bay	15.8	Good	Sufficient	Sufficient	Poor
Weston Main	18.6	Poor	Sufficient	Poor	Poor
Weston-Super-Mare Uphill Slipway	20.5	Sufficient	Poor	Sufficient	Sufficient
Brean	21.4	Excellent	Excellent	Good	Good
Berrow North of Unity Farm	25.7	Good	Excellent	Good	Excellent
Burnham Jetty North	30.3	No longer designated bathing water	No longer designated bathing water	No longer designated bathing water	No longer designated bathing water

Source: Environment Agency's Bathing Water Data Explorer and NRW's Bathing Water Data Explorer

Table 6-4 Bathing water quality of nearby bathing waters in Wales

Bathing Water	Distance (km)	Year			
		2019	2020	2021	2022
Wales					
Jackson's Bay Barry Island	28.0	Good	Sufficient	Sufficient	Sufficient
Whitmore Bay Barry Island	28.8	Excellent	Good	Good	Good
Cold Knap Barry	30.2	Excellent	Excellent	Excellent	Excellent

Source: Environment Agency's Bathing Water Data Explorer and NRW's Bathing Water Data Explorer

Water quality at Clevedon Beach (the closest at approximately 6.8 km) has routinely passed the "mandatory" bathing water requirements over the last four bathing seasons, with the higher "guideline" standard achieved on several occasions (Table 6-3). The beaches in England close to the Bedwyn Sands and NMG Licence Renewal Areas which have to failed annual bathing water quality testing during the last four bathing seasons were: Weston-Super-Mare Sand Bay (15.8 km away), Weston Main (18.6 km away) and Western-super-Mare Uphill Slipway (20.5 km away). However, Western-super-Mare Uphill Slipway is now categorised as Sufficient, reflecting a recent positive change.

The (international) Blue Flag Award scheme makes awards to beaches that achieve its stringent criteria. This includes meeting the highest water quality standards ('guideline' under the previous EU Bathing Water Directive, but 'excellent' under the revised Bathing Water Directive). As a consequence of the change in Bathing Water Directive, the water quality standards have become more difficult to achieve. None of the beaches described in Table 6-3 and Table 6-4 were designated 'Blue Flag' status in 2023 (Environment Agency, 2023a).

Trace metals and organics

Significant improvements in the treatment of substances prior to their release into the marine environment have led to concentrations of metals being typically below Environmental Quality Standard (EQS) values in UK waters. Historical metal smelting in Avonmouth and south Wales led to high cadmium concentrations in the Severn Estuary; however, concentrations have declined between 1995 (0.4 µg/l) and 2001 (0.09 µg/l) to levels below the EQS (MEMG, 2004). Elevated concentrations of nickel, mercury, zinc and cadmium were reported at the mouth of the Severn Estuary as part of the Severn Tidal Power study (DECC, 2010), related to increased run-off with proximity to industrial areas. Concentrations of Zn have been reported above EQS values in areas of South Wales (UKMMAS, 2010). A summary of trace metal contaminant concentrations in the Severn Estuary reported by Langston and Millward (2008) is shown in Table 6-5 including both fresh and saline EQS values for comparison due to the estuarine location of Bedwyn Sands and NMG.

Table 6-5 Dissolved and total trace metal concentrations in the Severn Estuary along with WFD (EQS) for fresh and saline waters

Trace Metal (Symbol)	WFD EQS (µg/L)		Dissolved Metal Concentration (µg/L)	Total Metal Concentration (µg/L)
	Fresh	Saline		
Arsenic (As)	50 (AA)	25 (AA)	2.3 ± 0.68	5.75 ± 5.41
Cadmium (Cd)	0.08 – 0.25 (AA), 0.45 – 1.5 (MAC)	0.2 (AA)	<0.25	3.28 ± 8.21
Chromium (Cr)	Cr (III): 0.0047 (AA); 0.032 (MAC); Cr (VI): 3.4 (AA)	Cr (VI): 0.6 (AA), 32 (MAC)	1.09 ± 0.76	16.3 ± 15.7
Copper (Cu)	1 – 28 (AA)	5 (AA)	2.83 ± 1.65	15.8 ± 24.4
Iron (Fe)	1,000 (AA)	1,000 (AA)	492 ± 515	14,173 ± 13,847
Lead (Pb)	7.2 (AA)	7.2 (AA)	5.3	275
Mercury (Hg)	0.05 (AA), 0.07 (MAC)	0.05 (AA), 0.07 (MAC)	0.014 ± 0.108	0.093 ± 0.009
Nickel (Ni)	20 (AA)	20 (AA)	<3	15.5 ± 19.4
Zinc (Zn)	8 – 125 (AA	40 (AA)	6.19 ± 2.9	133 ± 228
AA Annual Average; MAC Maximum Allowable Concentration.				

Source: Langston and Millward, 2008; DECC, 2010

Results presented by Jonas and Millward (2010) of dissolved metal concentrations in the Severn Estuary, measured between 2000 and 2005, generally match those shown in Table 6-3 (Langston and Millward, 2008). Dissolved arsenic concentrations in low salinity waters peaked at 1.5 µg/l, indicating a potential anthropogenic source of the contaminant, while chromium concentrations were typically <3.5 µg/l. The concentration of dissolved copper was generally <5 µg/l, with the exception of consistent values between 5 and 10 µg/l over two consecutive days of sampling in 2005 (24 and 25 August). Zinc concentrations were typically <10 µg/l (Jonas and Millward, 2010).

Contaminant concentrations recorded at four Environment Agency monitoring sites in the vicinity of Bedwyn Sands and NMG between 2018 and 2023 are presented in Table 6-6. Concentrations were typically below respective EQS values, although there remained some instances where exceedances have been observed. Chemical status for the Severn Lower transitional water body is currently (2022) moderate, as shown in Table 6-7. In 2016 when Severn Lower had a chemical status of good, it was recognised that the priority hazardous substance 'brominated diphenylether (BDPE) calc' had not been reported, and this parameter was previously (2015) failing to achieve good. In 2022, chemical status was moderate due to the priority hazardous substance 'mercury and its compounds'.

Table 6-6 Contaminant concentrations at four Environment Agency monitoring sites in the vicinity of Bedwyn Sands and NMG between 2018 and 2023

Trace Metals	EQS (µg/l)*		Dissolved Concentration (µg/l)			
	Fresh	Saline	1**	2	3	4***
Cadmium	0.08-0.25 (AA); 0.45-1.5 (MAC)	0.2 (AA)	-	0.0326-0.179 ($\bar{x}$ = 0.01; n = 15)	<0.03 – 0.184 ($\bar{x}$ = 0.101; n = 25)	-
Copper	1 (AA)	3.76 (AA)	2.28 – 2.44 ($\bar{x}$ = 2.35; n = 3)	2 – 2.6 ($\bar{x}$ = 2.36; n = 5)	-	-
Lead	1.2 (AA); 14 (MAC)	1.3 (AA); 14 (MAC)	-	-	<0.04 – 0.141 ($\bar{x}$ = 0.050; n = 25)	-
Zinc	13.1 (AA)	9.0 (AA)	-	-	-	2.5 – 4.1 ($\bar{x}$ = 3.32; n = 9)

*	Based on the WFD Directions 2015
**	Data is only available for 2018
***	Data is only available until 2021
AA	Annual Average
MAC	Maximum Allowable Concentration
1	Oldbury Power Station DS Point
2	Severn Estuary D/S Littleton Upon (EQSD)
3	Severn Estuary EQS Monitor off KWR at High Water
4	Severn Estuary EQS Monitor off Stupp Pill at High Water

Source: Contains Environment Agency information © Environment Agency and database right

Table 6-7 Latest 2022 classifications for the Severn Lower transitional waterbody

Trace Metal (symbol)	NRW Cycle 3 Classification
Arsenic (As)	High
Cadmium (Cd)	High
Chromium (Cr)	High
Copper (Cu)	High
Iron (Fe)	High
Lead (Pb)	High
Mercury (Hg)	Moderate
Nickel (Ni)	High
Zinc (Zn)	High
Overall chemical status: moderate	

The concentration of metals in water samples appears to generally reflect the proximity to anthropogenic sources, such as wastewater discharges and industrial settings. Metals which are predominantly of riverine origin tend to decrease in concentration in more saline waters. Conversely, anthropogenic sources of dissolved metals are often observed as the salinity increases downstream (close to the source) before decreasing into the Bristol Channel (Morris, 1984). The concentration of all total metals (including dissolved metals) is highest in the middle reaches of the Severn Estuary, around the location of the Bedwyn Sands and NMG Licence Renewal Areas, which could be associated with the trend in suspended solids (DECC, 2010). This is reflected by Nkopuyo and Everard (2021), in their assessment of heavy metals pollution in soft sediment of the Severn Estuary and Inner Bristol Channel

System. The authors found that Cd, Cr, Ni, Zn and Pb concentrations were higher in the summer than the winter, and the Severn Middle water body was the most polluted with these elements. The Severn Middle has currently failed its chemical classification (Environment Agency, 2023c).

Tributyltin (TBT) was used as a biocide in marine antifouling paints for yachts and large ships up to the mid-1980s; however, biological effects other than the desired antifouling properties of TBT containing products on marine organisms (e.g. reproductive ability) led to an EU-wide ban on the use of TBT. Historic concentrations of 3 ng/l have been measured in water samples from the Severn Estuary, and <4 ng/l in the Bristol Channel (DECC, 2010). TBT was not assessed for the Severn Lower transitional water body as part of the Cycle 1, or Cycle 2 Severn RBMPs (Environment Agency, 2009; Environment Agency and NRW, 2016). It was assessed for Cycle 3, and in this review, it was classed as "high" (NRW, 2023).

Little information is currently available for concentrations of polycyclic aromatic hydrocarbons (PAHs) or polychlorinated biphenyls (PCBs) in water samples. For two locations downstream of the Bedwyn Sands and NMG Licence Renewal Areas, Law *et al*. (1997) reported concentrations of total PAH in unfiltered water to range between 104 and 164 ng/l at Nash Point, and up to 1,150 ng/l adjacent to Port Talbot steelworks (DECC, 2010). As part of the contaminant review of the SEA 8 region, which covers the Western Approaches, Celtic Sea and English Channel, many PAH concentrations were found to have exceeded their maximum allowable concentration (MAC) at the mouth of the River Severn (Cefas, 2007).

Measurements of PCBs in mussel tissue (*Mytilus edulis*) and fish liver (plaice, dab, whiting and flounder) were assessed against OSPAR background assessment concentrations (BACs) and environmental assessment criteria (EACs) and reported in Charting Progress 2; these suggested exceedances in EACs within the Severn Estuary. However, PAH concentrations were not considered to represent a major problem to shellfish in Welsh waters (UKMMAS, 2010).

Radioactivity

Discharges of radioactive material are strictly controlled, and concentrations observed in the UK are reported annually (Radioactivity in Food and the Environment (RIFE) report series). GE Healthcare Limited, the operator of the Cardiff radiopharmaceutical plant, ceased manufacturing a range of radiolabelled products containing tritium (3H) in 2009, and products containing carbon-14 (14C) in 2010. Berkeley and Oldbury nuclear power stations, both of which are currently being decommissioned, are located in the upper reaches of the Severn Estuary, while Hinkley Point B (which ceased operation in 2022) and C are located downstream of Bedwyn Sands and NMG. In 2017, the total dose from all pathways and sources of radiation associated with these facilities was assessed to have been <0.005 mSv (Berkeley and Oldbury) and 0.032 mSv (Hinkley Point), equating to around 3% of the dose limit, with lesser values reported for the Cardiff radiochemical production centre for the same year (<0.005 mSv) (Environment Agency, 2018). The mud in the Bristol Channel has been independently tested by Cefas in 2009, 2013, 2017 and 2020 as commissioned by NRW and Hinkley Point C. In all four cases, the studies concluded that the levels of radioactivity in the mud are so low as a result of Hinkley Point C that they equate to 'not radioactive' under UK law (Cefas, 2021).

6.2.2 Sediment quality

There are few formal standards for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority and priority hazardous substances.

Cefas Guideline Action Levels have been prepared to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between AL1 and AL2 requires further consideration and testing before a decision can be made. The Cefas Guideline Action Levels should not be viewed as pass/fail thresholds. Furthermore, it should be noted that the Bedwyn Sands and NMG Licence Renewal does not consider the disposal of material at sea; however, these guidelines provide an appropriate context for consideration of contaminant levels in sediments.

Environment Agency monitoring data of sediments in the Severn Estuary was collected between 2007 and 2011, including the following two sites located close to the mouth of the River Avon (2.5 km from the Bedwyn Sands Licence Renewal Area):

- Severn Estuary off Holesmouth at High Water; and
- Severn Estuary off KWR at High Water.

Table 6-8 Cadmium and mercury sediment concentration from KWR and Holesmouth Environmental Agency monitoring stations

Metal	Cefas Guideline Action Level (mg/kg dw)		Year	Sediment Concentration (mg/kg dw)	
	AL1	AL2		Holesmouth	KWR
Cadmium	0.4	5	2007	<0.1	2.27
			2008	0.423	0.382
			2009	0.837	0.599
			2010	-	0.831
			2011	-	0.901
Mercury	0.3	3	2007	0.3	0.31
			2008	0.265	0.245
			2009	0.27	0.259
			2010	-	0.296
			2011	-	0.319

Source: Contains Environment Agency information © Environment Agency and database right

Table 6-8 presents cadmium and mercury sediment concentration from the two nearby monitoring sites. Sediment concentration for cadmium and mercury was less than AL2 for all samples collected, with many concentrations less than AL1 (particularly for mercury). It should be noted that the sediment type may be different between these two monitoring stations and the Bedwyn Sands and NMG Licence Renewal Areas. The sediment type at Bedwyn Sands and NMG is dominated by sandy material and will thus have lower contaminant concentrations than muddy areas.

Sediment concentration for various metals has also been measured by the Environment Agency at several monitoring sites further downstream (Bristol Channel), including the following:

- Severn Estuary adjacent to Weston-Super-Mare Black Rock O/F;
- Bridgwater Bay; and
- Bristol Channel Inner South Sediment WFD-BI.

Table 6-9 presents the maximum sediment concentration of metals measured from the three downstream monitoring sites. As with the two monitoring sites in close proximity to the Bedwyn Sands Licence Renewal Area, there were no metal concentrations in sediments which exceeded AL2 (although fewer samples were less than AL1).

Table 6-9 Maximum metal sediment concentration from Adjacent Western-Super-Mare, Bridgwater Bay and Bristol Channel Inner Environmental Agency monitoring stations

Metal	Cefas Action Level (mg/kg dw)		Year	Sediment Concentration (mg/kg)		
	AL1	AL2		Adjacent to Western-Super-Mare Black Rock O/F	Bridgwater Bay	Bristol Channel Inner South Sediment WFD-BI
Arsenic	20	100	2011	-	-	22.1
			2012	-	24	-
			2013	-	-	14.7
			2015	-	19.2	-
Cadmium	0.4	5	2008	0.225	-	-
			2009	0.452	-	-
			2010	0.653	-	-
			2011	0.751	-	0.618
			2012	-	0.194	-
			2013	-	-	0.144
			2015	-	0.246	-
Chromium	40	400	2011	-	-	89.2
			2012	-	115	-
			2013	-	-	94.8
			2015	-	93.7	-
Copper	40	400	2011	-	-	61.3
			2012	-	43	-
			2013	-	-	32.7
			2015	-	31.4	-
Lead	50	500	2011	-	-	111
			2012	-	77.7	-
			2013	-	-	108
			2015	-	63.1	-
Mercury	0.3	3	2008	0.196	-	-
			2009	0.226	-	-
			2010	0.203	-	-
			2011	0.22	-	0.317
			2012	-	0.305	-
			2013	-	-	0.183
			2015	-	0.270	-
Nickel	20	200	2011	-	-	40.3
			2012	-	58.1	-
			2013	-	-	41.2
			2015	-	38.2	-
Zinc	130	800	2011	-	-	268
			2012	-	245	-
			2013	-	-	196
			2015	-	218	-

According to Langston *et al*. (2003), trace metal concentrations in the sediments of the Severn Estuary and Bristol Channel are relatively uniform, reflecting the strong tidal mixing and fluid mud transport which disperse contaminants from their source. Duquesne *et al*. (2006) reported that sediment metal concentrations in the Severn Estuary and Bristol Channel were highest at sites close to industrial centres, but levels have decreased significantly over the last 30 years. Metal concentrations (mg/kg dry weight) ranged from 0.1 – 1.4 for cadmium, 10 – 90 for chromium, 1 – 47 for copper, 4 – 45 for nickel, 5 – 92 for lead and 20 – 340 for zinc. The authors indicate that the highest metal concentrations in deposited sediments were typically associated with the finest particulates at locations with muddy sediments, although acknowledges that this was not always the case at sites with predominantly sandy sediments. Nevertheless, the values reported by Duquesne *et al*. (2006) are in line with those reported by the Environment Agency (Table 6-4 and Table 6-5).

As part of a review of contaminant status of the SEA 8 region (Cefas, 2007), sediment samples from the Severn Estuary and Bristol Channel were analysed. Once normalised to aluminium concentration to highlight anthropogenic inputs (as opposed to granulometric and mineralogical differences), elevated concentrations of nickel, cadmium, mercury and zinc were found at the mouth of the Severn Estuary and were attributed to increased run-off in proximity to industrial areas (e.g. Bristol, Cardiff, Swansea) (Cefas, 2007).

In addition, the highest concentrations of PAHs in the SEA 8 region were found at two stations at the mouth of the River Severn (3,301 and 3,188 µg/kg dry weight). The highest total PCB concentration was also measured near the mouth of the River Severn (32.59 µg/kg dry weight) (Cefas, 2007). Concentrations of contaminants such as PAHs and PCBs contained in fine sediments such as muds and silts are higher than those measured in the water column due to adsorption of contaminants to sediment particles (MEMG, 2004). This is particularly true of the less soluble substances such as metals and many organic substances which tend to attach to suspended and deposited sediments. High levels of organic contamination are generally not associated with coarse sediments (MEMG, 2004), such as the sands and gravels targeted during aggregate dredging activities. The highest concentration of TBT in the sediments sampled between 1992 and 1997 from the Severn Estuary (around Swansea) was 2.37 µg/g wet weight (Cefas, 2000), with concentrations in the higher ranges occurring in the vicinity of the ports of Newport, Cardiff and Swansea (DECC, 2010).

6.3 Impact assessment

Dredging within Bedwyn Sand and NMG has the potential to affect water and sediment quality through the following activities and sources:

- **Draghead**: The action of the draghead will cause depressions in the seabed exposing underlying sediments. It will also disturb bed sediments and create a localised sediment plume in the water column;
- **Vessel Presence**: Vessel movements could result in a risk of accidents and spillages;
- **Overspill**: There will be a localised increase in suspended sediment concentrations (SSCs), leading to increased turbidity and the mobilisation and redistribution of a sediment plume, which may result in elevated concentrations of contaminants in the water column and/or a decrease in dissolved oxygen; and
- **Screening**: This will result in the same, albeit more localised, effects as the overspill (see above);

Impact pathways not included in the assessment: All identified impacts pathways relating to water and sediment quality have been taken forward in this assessment. However, toxic contamination from vessels (e.g. accidents and spillages) is not assessed in this section as it is addressed in Section 13 (Commercial and Recreational Navigation).

Impact pathways included in the assessment: The key impact pathways relating to water and sediment quality are the following:

- Potential changes to SSC (Section 6.3.1);
- Potential changes to dissolved oxygen (Section 6.3.2);
- Potential changes to levels of contaminants in water (Section 6.3.3); and
- Potential impacts from redistribution of sediment-bound chemical contaminants (Section 6.3.4).

An assessment of potential effects on WFD water bodies is provided in Appendix D.

6.3.1 Potential changes to suspended sediment concentrations

General scientific context

The potential for changes in water quality to occur arise primarily where sediment is released into the water column as a result of the action of the draghead on the seabed. As the draghead moves across the seabed, some of the sediment which is not extracted can be mobilised into the water column forming a sediment plume. This is particularly the case for fine sediments (<63 µm) which can become suspended more easily. Increased SSCs can cause a wide range of environmental impacts, including clogging of gills (e.g. filter-feeders) and smothering of sedentary organisms and reduction in light attenuation (Newell *et al*., 1998).

As noted above in Section 6.2.1, SSC within the Severn Estuary varies temporally, over semi-diurnal and semi-lunar timescales, and spatially, over vertical, lateral and longitudinal planes. Overall, the Estuary is considered highly turbid, with SSC concentrations typically in the range of 81-336 mg/l (DECC, 2010) and exceeding 500 mg/l on occasion (Kirby, 2010).

Project impact assessment

The proportion of fine material within the Bedwyn Sand and NMG Licence Renewal Areas is minimal; dredge cargo PSA analysis shows sediment type is predominantly sand (ABPmer, 2022), meaning that any disturbance of fine material from aggregate dredging operations will be limited in magnitude and extent. Background concentrations of suspended sediments exceeding 500 mg/l have been reported within the Severn Estuary (Kirby, 1986; 2010). Therefore, it is highly unlikely that dredging operations would lead to any notable increase in SSC above the levels of background variability.

A plume study undertaken by HR Wallingford (2010) for the English south coast predicted that increases in SSCs experienced outside of a proposed licence area, comprised primarily of sandy sediment (similar to Bedwyn Sands and NMG), would typically be <20 mg/l above background levels as a result of the aggregate dredging activity, except when dredging occurred close to the boundary. Even when this does occur, SSCs of more than 50 mg/l were not predicted to occur further than 250 m from the boundary, whilst concentrations of more than 100 mg/l were only likely to be experienced within 100 m of the active dredging zone.

With specific reference to the activity within the Bedwyn and NMG sites, aggregate extraction activity is limited to a period a few hours either side of high water, due to the otherwise shallow nature of the extraction sites. This means that water depths across the extraction site, and the wider region, are generally small and that any material in put into suspension by the extraction activity will not have far to settle out. This shallow water depth, along with the relatively coarse nature of the bed material and the relatively slack water conditions around high water, means that any material will settle quickly to the bed and any associated dispersion across the wider study area will be severely limited. The values described above (from HRW Wallingford, 2010 are, therefore, considered to provide an upper-limit worst case for changes to SSC, with actual magnitudes and extents of effect being considerably lower. Therefore, in the context of the extraction activity and the Severn Estuary's natural suspended sediment regime (as outlined in Section 6.2.1), for which high SSCs are common, any potential increases in SSC are expected to be negligible.

It is important to note that these minimal increases in SSC will also be short-term in duration while dredging occurs and only in the streamline of the dredger. Dredgers will not be present on the Areas all the time. As a result, for the vast majority of the time over the licensing period, there will be no increase in SSC attributable to the dredging operations. Screening is also considered to be restricted by the use of a 4 mm mesh as discussed in Section 3.4. and, therefore, the potential for increases in SSC in the far-field is similarly limited (as defined in Section 4.1).

Given that the magnitude of change in SSC is negligible and the probability of occurrence is low, the exposure of water quality receptors is negligible. Despite a potentially high sensitivity/importance of water quality receptors to increases in SSC, there is no vulnerability, and the impact of the suspended sediment plume is therefore assessed as **insignificant**.

6.3.2 Potential changes to dissolved oxygen

General Scientific Context

The increase in chemical and biological oxygen demand associated with elevated SSCs in the water column can have the potential to reduce dissolved oxygen concentrations (LaSalle, 1990). This effect is associated with organic rich material, such as peat or alluvium.

Project Impact Assessment

The Bedwyn Sands and NMG Licence Renewal Areas are primarily composed of sand as opposed to organic-rich material (see ABPmer, 2022). Waters in the Severn Estuary are well mixed, as a result of the hyper-tidal regime within the Estuary, and are typically well oxygenated, with bottom oxygen levels at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site consistently above 7 mg/l throughout the year (Section 6.2.1). Furthermore, the potential for changes in SSC associated with dredging operations is assessed as insignificant (see above; Section 6.3.1).

Given the predominant sediment type and well mixed nature of the Severn Estuary, the probability of occurrence is considered to be negligible, which leads to a negligible exposure to change. Despite a potentially high sensitivity/importance of water quality receptors to changes in dissolved oxygen concentration, there is no vulnerability, and the impact is therefore considered to be **insignificant**.

6.3.3 Potential changes to levels of contaminants in water

General Scientific Context

Re-suspension of sediment as a result of draghead disturbance can lead to the release and mobilisation of sediment-bound contaminants into the water column. Contaminants in sediments are typically associated with finer material as opposed to coarse sediment (MEMG, 2004).

Project Impact Assessment

In the absence of formal sediment EQSs, sediment concentrations have been compared to Cefas Guideline Action Levels, used to determine the suitability of material for disposal in the marine environment.

All sediment samples analysed by the Environment Agency from 2007-2011/15 (sediment sampling does not continue after 2011/15) for five sites (KWR, Holesmouth, Adjacent to Wester-Super-Mare, Bridgewater Bay, Bristol Channel Inner) in the vicinity of the Bedwyn Sands and NMG Licence Renewal Areas have been below Action Level 2, above which material would be considered unsuitable for disposal (see Section 6.2). It is important to note that sediment contaminant concentrations from these nearby monitoring stations may not provide a good comparison, as the sites are likely to consist of greater mud (fine) material and thus contain higher contaminant levels than the coarser/sandy sediment of Bedwyn Sands and NMG.

Given that the scale of sediment re-suspension as a result of aggregate dredging operations is minimal in comparison to the Severn Estuary's natural tidal influence, the magnitude of change is considered to be low. The probability of occurrence is also considered to be low, as the sediments being dredged are predominantly comprised of sands and relatively low concentrations of adsorbed contaminants would be expected compared to finer sediments (i.e. mud/silt). Consequently, the exposure to change is assessed as negligible. Despite a potentially high sensitivity/importance of water quality receptors to changes in levels of contaminants in the water, there is no vulnerability, and the impact is therefore considered to be **insignificant**.

6.3.4 Potential impacts from redistribution of sediment-bound chemical contaminants

General scientific context

The potential to impact the marine environment as a result of any sediment-bound contaminants arises primarily when the sediment that is released into the water column disperses and deposits elsewhere. Aggregate extraction will not input any additional contaminants into the system but could remove and potentially redistribute any contaminants already present in the sediments.

Project impact assessment

Sediments being dredged from the Bedwyn Sands and NMGs Licence Renewal Areas are predominantly sand and, as previously mentioned, relatively low concentrations of adsorbed contaminants would be expected compared to finer sediments (i.e. mud/silt). Furthermore, the potential for a sediment plume to develop, and thus transport contaminated sediment, is minimal due to the limited composition of fine material (ABPmer, 2022) and the extraction operations within relatively shallow water and during relatively slack flow conditions over high water. This suggests it is unlikely that any sediment, mobilised due to aggregate dredging operations, would be redistributed considerable distances away from the boundaries of the Licence Renewal Areas. The impact of the natural tidal regime in the Severn Estuary greatly outweighs the potential redistribution of sediment attributed to dredging.

It is worth noting that the Bedwyn Sands and NMG Licence Renewal is not associated with the disposal of material in the marine environment, but simply the extraction of marine aggregate. Furthermore, the application to dredge from Bedwyn Sands and NMG is for a Licence Renewal (i.e. to continue dredging activities), as opposed to commencing dredging operations in a previously undisturbed area.

Given the scale of sediment re-suspension and limited potential for sediment to be transported considerable distances, the magnitude of change and probability of occurrence due to dredging are both considered to be negligible. Consequently, the exposure to change is assessed as negligible. Despite a potentially high sensitivity/importance of water quality receptors to the redistribution of contaminated sediments, there is no vulnerability, and the impact is therefore considered to be **insignificant**.

6.4 Summary and conclusions

Table 6-10 summarises the impact assessment judgements, presents conclusions and provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 6-10 Water and sediment quality impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, it is considered that the impact pathways associated with water and sediment quality all have a negligible exposure to change.
Estimation of vulnerability	Based on the evidence in this assessment, it is estimated that the vulnerability of features potentially impacted by water and sediment quality is none (despite a potentially high sensitivity of receptors).
Estimation of significance	Considering evidence presented in this assessment on the vulnerability of receptors, and despite the potentially high importance of features potentially impacted by water and sediment quality pathways, the estimation of significance is insignificant.
Conclusion	The assessment has concluded that overall, the impact on existing water and sediment quality is considered to be **insignificant** and will not require any mitigation.
Confidence Assessment	The data on which this assessment is based uses conservative assumptions. Confidence in the assessment is medium to high.

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7 Nature Conservation and Ecology

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on nature conservation receptors. Section 7.1 outlines the data sources and consultation used to inform the baseline and assessment. Sections 7.2 and 7.3 cover the baseline and impact assessment relating to nature conservation, respectively, and Section 7.4 provides a brief conclusion.

A definition of the study area applied within this ES is provided in Section 4.1. For the purposes of this assessment, the 'wider' study area covers the Severn Estuary. The location of Bedwyn Sands, and NMG in relation to Protected Sites and nationally designated sites within 15 km of the proposed dredging activities is provided (see Figure 7-1). As mobile features of more distant Protected Sites and nationally designated sites may overlap with the impact zones (primary and secondary), consideration is given to these within the relevant sections of this ES, where appropriate.

7.1 Data sources and consultation

7.1.1 Data sources

The principal data sources used in this assessment are as follows:

- The Joint Nature Conservation Committee (JNCC) website (JNCC, 2023a), which provides definitions of protected areas and their respective features;
- MPA Mapper (JNCC, 2023b), which provides information on the MPAs designated in UK and Crown Dependency waters.
- Multi-Agency Geographic Information for the Countryside (MAGIC) Interactive Map (Natural England, 2023a); this provides the location of all designated conservation sites in the area;
- Natura 2000 (now National Site Network) standard data forms/information sheets for each designation, as well as related GIS shapefiles;
- Welsh Government website (Welsh Government, 2023), for spatial data sets relevant to nature conservation and ecology;
- Natural England website (Natural England, 2023b) which provides detailed information about sites designated for their wildlife or geological interest; and
- NRW website (Natural Resource Wales, 2023)

7.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within the Environmental Statement.

In relation to Nature Conservation and Ecology, the following nature conservation sites were explicitly mentioned for consideration in relation to the proposed works:

- Severn Estuary / Môr Hafren Special Area of Conservation (SAC);
- Severn Estuary / Môr Hafren Special Area of Protection (SPA);
- Severn Estuary / Môr Hafren Wetland of International Importance under the Ramsar Convention (Ramsar Site);
- River Usk SAC;
- River Wye SAC; and
- Severn Estuary / Môr Hafren Site of Special Scientific Interest (SSSI).

As a consequence of overlap with Marine Mammal Management Units (MMMUs), it was advised that the nearest SACs designated for harbour porpoise (Bristol Channel Approaches SAC) and grey seal (Pembrokeshire Marine SAC) be considered for potential effects from the proposal.

Given the potential for a Likely Significant Effect (LSE) on Protected Sites, consultation advice received during scoping recommended that the proposal is taken through an appropriate assessment. It was noted that particular consideration should be applied to the Annex I habitat 'sandbanks which are slightly covered by sea water all the time' (H1110).

7.2 Review of baseline understanding

7.2.1 Protected Sites

Three Protected Sites are present within 10 km of the study area. These are the Severn Estuary/Môr Hafren (SAC), the Severn Estuary SPA, and the Severn Estuary/Môr Hafren Ramsar site (Figure 7-1). The Renewal Areas directly overlap with all of these Protected Sites. The habitats within these sites support important numbers of resident and migratory birds and marine species. Together, these sites form the Severn Estuary/Môr Hafren European Marine Site, which protects the following features:

- Estuaries;
- Intertidal mud and sandflats;
- Saltmarsh;
- Reefs;
- Subtidal sandbanks;
- Migratory fish; and
- Birds (overwintering and on passage).

Mobile and migratory fish species of the River Usk and River Wye SACs could be affected by the proposed dredging activities when on migration to and from the rivers. The diadromous fish features of the River Usk and River Wye SACs, along with the qualifying features of the Severn Estuary/Môr Hafren SAC, the Severn Estuary SPA, and the Severn Estuary/Môr Hafren Ramsar site are considered within the respective species group sections of the ES (Sections 8, 9, 10 and 11), as well as in the Appropriate Assessment signposting document (Appendix C).

7.2.2 Nationally Designated Sites

In addition to the above internationally protected sites, the Bedwyn Sands and NMG Renewal Areas overlap with the Severn Estuary SSSI, which is designated for a range of nationally important features including saltmarsh, birds, eelgrass, intertidal mud, sand and rock. The SSSI is also noted for the estuarine processes that support these features, particularly the mobile sand and mud banks. An assessment of the potential changes to coastal processes and sediment transport from the proposal is carried out in Section 5 bird receptors in Sections 8 and 10, respectively.

There are no MCZs that overlap with the Renewal Areas. The closest to the Renewal Areas is the Bideford to Foreland Point MCZ, located off the north coast of Devon, >50 km from the Renewal Areas. Additionally, there are no other nationally designated sites, Areas of Outstanding Natural Beauty (AONB) or World Heritage Sites located within the study area for Bedwyn Sands or NMG.

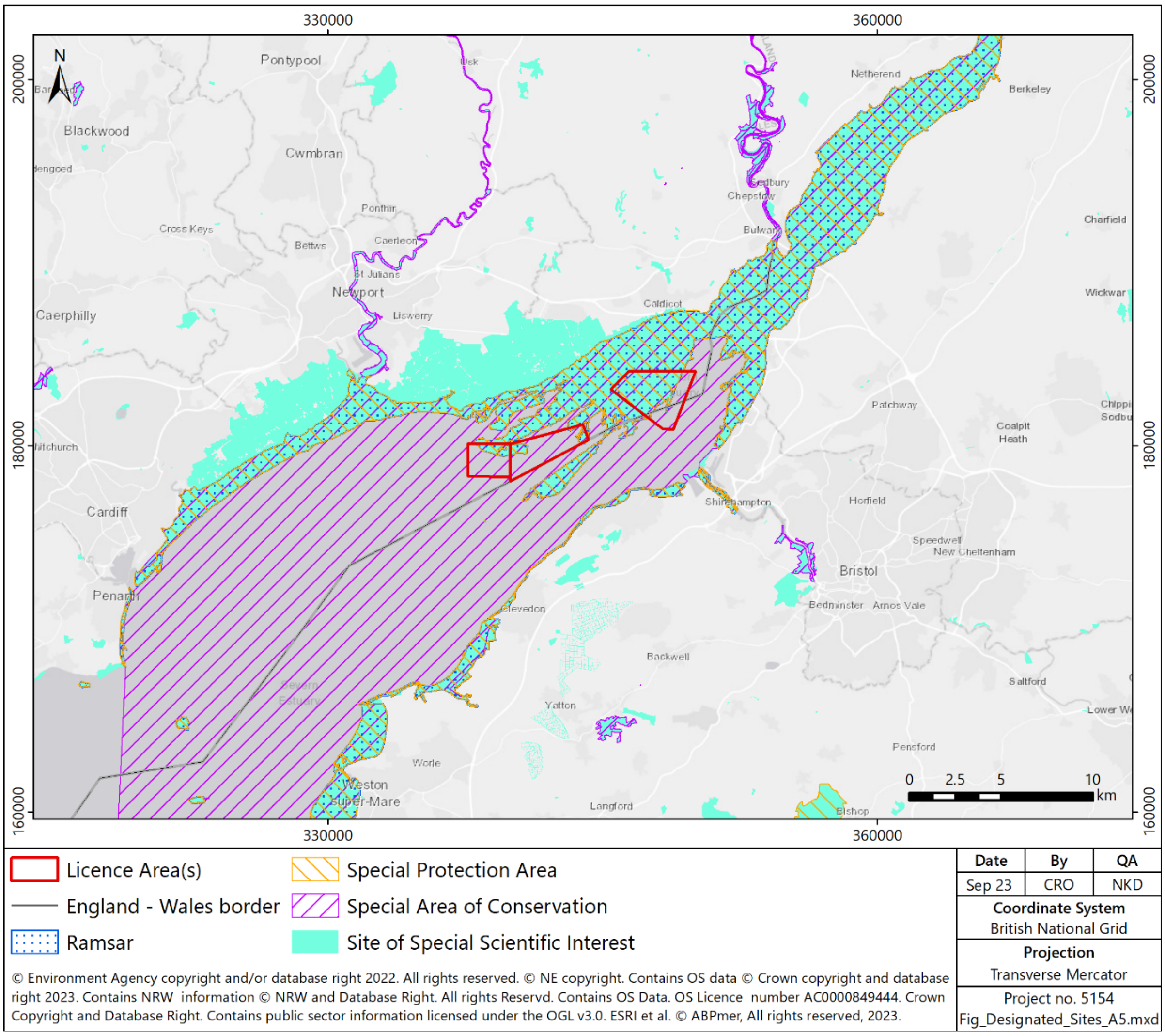

Figure 7-1 Protected Sites and nationally designated sites within 15 km to the Renewal Areas

7.2.3 Biodiversity Strategies and Plans

UK Biodiversity Action Plan (BAP) priority species and habitats were those that were identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). The original lists of UK BAP priority species and habitats were created between 1995 and 1999. These were subsequently updated in 2007.

Due to devolution and the creation of country-level biodiversity strategies, much of the work previously carried out under the UK BAP is now focused at a country level.

The original BAP habitats and species lists were used to develop statutory lists of priority species and habitats, as required under the Natural Environment and Rural Communities (NERC) Act 2006. The NERC Act came into force in October 2006. Section 41 of the Act requires the Secretary of State, in consultation with Natural England, to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The Section 41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under Section 40 of the NERC Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions. In England, there are 943 species of principal importance and 56 habitats of principal importance included on the Section 41 list; coastal and marine species are listed in Appendix B.

Under the Environment (Wales) Act (2016), Section 7 requires biodiversity lists to be produced. These lists include types of habitats which are of "Principal Importance" for the purpose of maintain and enhancing biodiversity in relation to Wales. This list supersedes the duty in Section 42 of the NERC Act 2006. In addition, marine habitats can be protected under the OSPAR Convention, which has established a list of "threatened and/or declining species and habitats" in the North-East Atlantic. In Wales, there are 557 species of principal importance ('Section 7 species') and 55 habitats of principal importance ('Section 7 habitats'); coastal and marine species are listed in Appendix B

Various habitats and species which are of principal importance are located within, or near, to the study area. Reference should be made to the ecology sections of this ES for habitat/species specific information (Sections 8-11).

7.2.4 Protected Species and Habitats

Various species of marine animals are protected from being killed, injured or disturbed under provisions in the Habitats Directive and Section 9(4) and Schedule 5 of the Wildlife and Countryside Act 1981 (WACA) (as amended by the Countryside and Rights of Way Act 2000). Of relevance to this proposal are dolphins and porpoises. The presence of these species, as well as impacts upon them, are discussed in Section 11.

Additionally, all turtles, dolphins, porpoise and whale species are European Protected Species (EPS) and receive protection from being killed, injured or disturbed under The Conservation of Habitats and Species Regulations 2017.

Four marine species listed in Annex IV of the Habitats Directive are known to regularly occur in UK coastal and offshore waters: the grey seal, harbour seal, bottlenose dolphin and harbour porpoise. Although grey seals are occasionally seen, cetaceans are not considered a common occurrence in the study area (e.g. Evans and Waggitt, 2023). However, given the regional presence of these features in the wider study area extending into the Bristol Channel, the potential for impacts upon them is discussed in Section 11.

7.3 Impact assessment

This section considers the potential changes to baseline conditions which may be brought about by aggregate extraction from Bedwyn Sands and NMG. The dredging activity has the potential to affect Protected Sites and conservation features through the following pathways:

- **Loss/damage and/or disturbance of habitats and/or species** – Within the direct footprint and indirectly;
- **Loss or changes to foraging habitat** – Both within the direct footprint and indirectly from changes to the hydrodynamic regime;
- **Toxic contamination** – Fluids, fuels and/or other materials transferred into the marine environment during dredging operations and/or release of contaminated sediments;
- **Non-toxic contamination** – Increase in turbidity associated with the release of suspended sediments associated with dredging activities;
- **Noise and visual disturbance** – Disturbance to birds, fish and/or marine mammals caused by visual and noise stimuli from vessels, machinery and human presence; and
- **Biological disturbance –** Effect on habitats and communities from the introduction of non-native species.

Consideration has been given to assessing site specific variations and potential disturbance under Section 125 and 126 of the Marine and Coastal Access Act 2009. Under The Conservation of Habitats and Species Regulations 2017, consideration has also been given as to whether the aggregate extraction from Bedwyn Sands and/or NMG has the potential to result in a likely significant effect (LSE) on Protected Sites. Bedwyn Sands and NMG have the potential to significantly affect features of the Severn Estuary/Môr Hafren SAC, the Severn Estuary SPA, and the Severn Estuary/Môr Hafren Ramsar site. Potential effects are therefore assessed under regulation 61 of The Conservation of Habitats and Species Regulations 2017.

There is also the potential for a LSE on mobile SAC, SPA and Ramsar interest features that could be using areas directly or indirectly affected by the proposed dredging at Bedwyn Sands and NMG. These interest features and the potential impacts are considered in Sections 8, 9, 10, 11 and 19. Additionally, an Appropriate Assessment (AA) signposting document is provided in Appendix C.

Section 41 NERC species and habitats of principal importance in England and Section 7 species and habitats of principal importance in Wales are assessed in their respective topic sections, where applicable (i.e. Sections 8, 9, 10 and 11).

As noted above, Bedwyn Sands and NMG areas overlap with the Severn Estuary SSSI. Benthic features of this SSSI, including the mobile mud and sand banks are assessed in Section 8, with reference to the conclusions presented in Section 5 (physical processes) in relation to estuarine processes and Section 6 (water and sediment quality), as relevant. Mobile features are assessed within Sections 9, 10 and 11.

No MCZs, World Heritage Sites, Areas of Outstanding Natural Beauty (AONBs), or local wildlife and geological sites have been identified as being at risk from dredging activities and therefore these are not considered further in this assessment.

7.4 Summary and conclusions

All features for which the sites are designated have been considered in the relevant sections within this ES (i.e. Sections 5, 8, 9, 10 and 11) with further consideration given to these features, where relevant, in relation to cumulative effects (Section 19). Given the proximity of the proposed works to Protected Sites, the potential for an LSE could not be ruled out, and an AA was undertaken (see Appendix C). The AA concludes that there is no potential for an AEOI on the interest features of Protected Sites either alone and/or in-combination with other plans and projects.

7.5 References

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8 Benthic Habitats and Species

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on benthic habitat and species. Section 8.1 outlines the data sources and organisations/stakeholders consulted to inform the baseline and assessment. Sections 8.2 and 8.3 cover the baseline and impact assessment relating to benthic habitats, respectively, and Section 8.4 provides a brief conclusion.

A definition of the study area applied within this ES is provided in Section 4.1. For the purposes of this assessment the 'immediate study area' comprises both the footprint of the licence applications for Bedwyn Sands and NMG (coinciding with the PIZ) and the potential SIZs as are represented by a 500 m buffer around the footprint of the dredging areas. For the purposes of the assessment for this topic, the 'wider study area' refers to the Severn Estuary.

8.1 Data sources and consultation

8.1.1 Data sources

The principal data sources used in this assessment are as follows:

- Bedwyn Sands and NMG: 5-year Substantive Review (ABPmer, 2022a);
- Area 531 Environmental Statement (ABPmer, 2019);
- Bedwyn Sands Environmental Statement (ABPmer, 2015);
- Benthic Monitoring at NMG: 2005 Benthic faunal survey using grab sampling (Henderson *et al.*, 2006);
- NMG Annual Sediment Monitoring Data (Pisces, 2009; Shoreline Surveys, 2012, 2013 and 2014);
- Intertidal Phase 1 Habitat Mapping Surveys / biotope mapping; for Wales, (1996 to 2004) (Brazier *et al.*, 2007); for English side of the Severn Estuary (2002 to 2004) (Emu, 2006);
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) Benthic and Fish Surveys of NMG (1999 and 2000) (HR Wallingford, 2003);
- Analysis of subtidal sand samples, Severn Estuary (1986 to 1995) (Mettam, 1997);
- Scientific review based on subtidal macrofaunal and sediment sampling undertaken in 1988 in the Severn Estuary and Inner Bristol Channel (Mettam *et al.*, 1994);
- The Structure and Functioning of the Benthic Macrofauna of the Bristol Channel and Severn Estuary (Warwick and Somerfield, 2010);
- Distribution of Sublittoral Benthic Macrofauna Associations in the Bristol Channel (Benthic sampling at 155 stations, 1972-1973) (Warwick and Uncles, 1980; Warwick and Davies, 1977); and
- State of the Severn Estuary Report: Summary information on invasive species in the Severn Estuary (The Severn Estuary Partnership, 2011).

8.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES in relation to benthic habitats and species. This included the need for adequate consideration of designated features, in particular the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'. The potential impacts on this habitat, as well as others, are assessed within this Section of the ES, while further consideration is given to Protected Sites and their features within the AA signposting document (Appendix C). Further to this advice, it was noted that details on the benthic receptors scoped into the assessment should be provided (see Section 8.2 below).

While the Scoping Opinions received noted that the potential aggregate dredging impact pathways detailed within the Scoping Report (ABPmer, 2022b) were suitable for the assessment of dredging at the Bedwyn Sands and NMG extraction areas, consideration should be given to hopper water exchange as a viable INNS pathway. The intention to use RSMP survey data was accepted, with both MMO and NRW Permitting Service (PS) recommending that this benthic monitoring is continued if the Marine Licences are renewed.

Previous consultation advice received in relation to the Area 531 ES was also acknowledged. Regional Seabed Monitoring Programme (RSMP) style surveys were carried out to inform baseline characterisation.

8.2 Review of baseline understanding

8.2.1 Broad overview

Broadscale habitat mapping indicates that mud and muddy sand, sand, shingle, rock, saltmarsh and fucoids are the most common marine habitats present throughout the Severn Estuary (Emu, 2006; Brazier *et al*. 2007; Natural England and CCW, 2008). Benthic species distribution within the Estuary is mainly influenced by sediment type and the level of consolidation (Davies, 1991); however, in general the physical processes caused by strong tidal currents result in a benthic environment where established colonisation is difficult. A species poor benthic assemblage is therefore characteristic of the Estuary, although biomass is not necessarily low (Boyden and Little, 1973).

At a localised level, these findings are supported by previous benthic monitoring at Bedwyn Sands and NMG which has shown these areas to be generally impoverished in terms of fauna (Henderson *et al*., 2006; Brazier *et al*., 2007). This is not unexpected, as strongly tide-swept sand environments have limited food availability and are typically characterised by a species poor, macrofaunal community (e.g. Tillin, 2016).

A programme of seabed sampling has been undertaken in support of the Bedwyn Sands and NMG licence conditions. The benthic sampling followed an RSMP-type sampling grid developed in consultation with Cefas, with a specific plan devised for the combined monitoring of the Bedwyn and NMG sites (see ABPmer, 2022a). As part of discharging the defined licence conditions, benthic ecology surveys (following the defined RSMP-type monitoring plan) were carried out during Year 1 (2017) of the current licence period (the characterisation survey) and again during Year 4 (2020) of the licence term. The results from these surveys informed a 5-year substantive review (ABPmer, 2022a).

8.2.2 Intertidal overview

The Severn Estuary contains a wide variety of intertidal habitats, including mudflat, sandflat, gravel and rocky shores. Large-scale biotope mapping surveys have identified the spatial extent of intertidal habitats within the Severn Estuary. NRW (formerly CCW) surveyed the Welsh shore of Severn Estuary as part of a wider Phase 1 intertidal habitat mapping survey of the entire Welsh coast between 1996 and 2004 (Brazier *et al*., 2007). Natural England subsequently commissioned a survey of the English side of the Severn Estuary which was undertaken between 2003 and 2004 (Emu, 2006). Summary information on the most commonly occurring lifeforms is presented in Table 8-1.

Table 8-1 Broad distribution of intertidal habitat types recorded in the NRW (formerly CCW) and Natural England Phase 1 intertidal habitat mapping surveys

Habitat Type	Summary
Mud and muddy sand	Large areas of intertidal mudflat occur along the English foreshore between Steart and Berrow Flats and on the Welsh side between Cardiff and the Severn Bridge. These habitats typically consist of littoral sandy mud, muddy sand and littoral mud biotopes.
Sand	Sandflats are mainly found on the Middle Grounds and Welsh Grounds and consists of impoverished mobile sand biotopes.
Shingle	The shingle habitat of the Severn Estuary is predominantly located in Bridgwater Bay where the intertidal flats between Hinkley Point, and the River Brue are backed by low shingle ridges. Shingle ridges are also apparent landward of the rocky outcrops, on the English side of the estuary, in the vicinity of the Severn Crossing and directly opposite this area on the Welsh bank.
Rock	Large areas of rocky intertidal are located throughout the Severn Estuary although they are typically more dominant on the English side of the Estuary. Areas in which rocky shore appears to dominate the coastal zone include in the vicinity of the Severn Crossing, between Portishead and Sand Point, Lydney Cliff and Purton Passage.
Saltmarsh	Sections of the Severn Estuary that support large extents of saltmarsh include Wentloodge Levels, Caldicot Levels, Gwent Levels, around the Severn Crossings and into the inner reaches of the Estuary. Within Bridgwater Bay the saltmarsh is concentrated between Hinkley Point and Burnham-on-Sea, extending into the estuaries of the rivers Parrett and Brue.
Fucoids	Predominantly located at Hinkley Point and in the vicinity of the Severn Crossing in areas of mixed sediment and shingle.

Source: Brazier *et al.,* 2007; Emu, 2006

Most of these habitats, or sub-categories thereof, are considered Habitats of Principal Importance under the 2006 NERC Act (England), as well as the Environment (Wales) Act 2016. This includes saltmarshes and mudflats, as well as coastal sand dunes, vegetated shingle, maritime cliffs and slopes, rocky habitats and intertidal boulders.

The biotope mapping surveys also recorded several further habitats and species in the Severn Estuary which are considered nationally rare or important (Brazier *et al*., 2007; NE and CCW, 2008; Emu, 2006). These include:

- Eelgrass beds: Eelgrass beds occur on some of the more sheltered mudflats around the Welsh side of the Severn Crossing. There are three species of Zostera in the UK, common eelgrass *Z. marina*, narrow-leaved eelgrass Z. *angustifolia* and dwarf eelgrass, *Z. noltii;* all three species are present within the Severn Estuary;
- *Sabellaria alveolata* reefs: Sabellaria reefs are discussed in more detail below (Subtidal Habitats);
- Piddock habitat: Piddock species were recorded burrowing into soft rock and firm clay near Penarth; and
- Amphipod species: Gammarids considered scarce in the UK such as *Gammarus chevreuxi* (recorded near to Cardiff) and *G. insensibilis* (recorded along the lower littoral fringe at Chapel Rocks).

The dynamic environment and large tidal range within the Severn Estuary create a range of physical conditions to which inhabiting organisms are exposed. Numerous studies have investigated the relationship between the fauna of the intertidal habitats and the physical properties of the Estuary (Boyden and Little, 1973; Warwick and Davis, 1977; Warwick *et al*., 1989; Davies, 1991). Only above Sharpness does the distribution of species appear to be limited by salinity (Boyden and Little, 1973). Elsewhere, the large tidal range, funnelling, strong tidal streams and high suspended sediment concentrations create difficult conditions for the colonisation of benthic species. In general, species composition is determined by differences in sediment type and the level of consolidation (Davies, 1991). The tidal tributary estuaries also have a similar invertebrate faunal diversity to the main Estuary. The dynamic nature of the system also means that sediments are mobile and can change in location and nature over a range of timescales. This high level of variability, combined with the physical stresses of an estuarine environment led to a species poor assemblage of invertebrates, although not necessarily a low biomass.

Mud and sandflat habitat are dominated by infaunal species such as polychaete worms, amphipod crustaceans and gastropod molluscs. Species such as the gastropod *Hydrobia ulvae*, the bivalve *Macoma balthica* and the polychaete *Hediste diversicolor* occur in abundance in areas of mudflat, with areas of sandflat more impoverished, characterised by low abundances of sand dwelling mobile amphipods and errant polychaetes (Warwick and Somerfield, 2010; Henderson *et al*., 2006; Mettam, 1997; HR Wallingford, 2003). The composition of intertidal macrofaunal assemblages in the Severn Estuary has been shown to be different to those of other estuaries in the south and south-west of England such as Poole Harbour and Southampton Water (Warwick *et al*., 1991). The largest differences were attributed to an elevated abundance of *N. hombergii, H. diversicolor, M. balthica* and *Bathyporeia* sp. (Warwick *et al*., 1991). Typically, areas that have high silt content also have a high abundance of the amphipod *Corophium volutator* and laver spire shell *H. ulvae* (Boyden and Little, 1973). It is hypothesised that the faunal differences between the Severn Estuary and other estuaries are not caused by sediment characteristics alone. The large hypertidal range, high turbidity concentration and substrate instability are also important drivers (Warwick *et al*., 1989). Intertidal mudflats and sandflats are an Annex 1 qualifying feature of the Severn Estuary SAC and are also a habitat of principal importance in both England and Wales.

Intertidal rocky shore and mixed sediment habitat is composed of a range of different substrate features including boulders, expanses of rock platforms, mussel/cobble scars and rock pools. They support a number of epifaunal species including barnacles, limpets, littorinids, fucoids and green ephemeral algae. Hydroid rock pools, which are considered rare in the UK occur at a number of mid and lower eulittoral and algal free rocky locations within the study area e.g. Aust and Brean Down. Typical hydroid species include *Tubularia indivisa* and *Sertularia argentea* (Bamber and Coughlan, 1987; Seaby and Somes, 2001; Langston *et al*., 2003).

8.2.3 Subtidal overview

Subtidal benthic communities of the Severn Estuary are generally impoverished due to seabed scouring and mobility of sediments that result from its large tidal range (Mettam *et al*., 1994; Warwick and Somerfield, 2010; Ecospan Environmental Ltd., 2013). In the Severn Estuary, subtidal habitats have different sedimentary compositions, including muddy sands, clean sands, rock and gravely areas (Langston *et al*., 2003). However, the predominant unconsolidated sediments are muds and sands, the relative composition of which varies throughout the Estuary. Each of these sediment types, and the differing physical processes in operation, support a different invertebrate assemblage (Warwick and Davies, 1977; Warwick and Uncles, 1980; Mettam *et al*., 1989).

Benthic sampling of the Severn Estuary was undertaken in April and May 1988 as part of a Severn Tidal Group funded study (Mettam *et al*., 1989; Mettam *et al*., 1994). Samples were collected from 589 stations between the second Severn Crossing and Porthcawl. The study represents the most comprehensive benthic survey of the Severn Estuary. Using multivariate statistical analysis, the study identified six distinct subtidal faunal assemblage groups (and also two intertidal groups). Further information on each of the subtidal groups is provided below:

1. Hard surfaces with *Sabellaria*: Subtidal areas, mostly rock and hard substrate with *Sabellaria* reef;
2. Subtidal gravelly substrates with *Exogone Naidina*: Subtidal gravels found either in isolation or small areas. Characterised by the polychaete *E. naidina;*
3. Subtidal soft fluid mud with *N. hombergii* and *Tubificoides amplivasatus*: Areas of settled muds in the subtidal and lower intertidal. Characterised by the polychaete N. *hombergii* and the oligochaete *T. amplivasatus;*
4. Subtidal sand with *N. cirrosa*. Fine to medium sands, which occurs subtidally to the north of Nash Sands and on the outer part of the Welsh Grounds. Characterised by the polychaete *N. cirrosa;*
5. Subtidal sand with *E. pulchra*. Coarse sands on linear sand banks (including Culver and Cardiff Grounds) and part of the westerly edge of the sands in the main Severn Estuary. The sites were typified by the isopod *E. pulchra;* and
6. Impoverished subtidal sand with a general absence of fauna. Extending over large areas of subtidal sand primarily to the east of Bridgwater Bay. Samples were generally very impoverished, dominated by opportunistic capitellids and mobile crustaceans. Some samples were afaunal.

The data collected as part of the Severn Tidal Group funded study, along with other data collected between 1986 and 1995, was analysed by Mettam (1997). The study identified a range of sedimentary habitat types. Summary information on the distribution of these broad habitat types is shown in Table 8-2. Typical species communities associated with shallow subtidal sandbanks are considered assemblage extensions of lower intertidal communities and have a restricted fauna consisting of mobile species such as polychaetes and crustaceans. Subtidal sandbanks are an Annex 1 qualifying feature of the Severn Estuary SAC.

Greater species richness is associated with reefs of *S. alveolata*, which extended well into the Estuary (Mettam, 1997; Mettam *et al*., 1989). *S. alveolata* reefs in the UK are predominantly an intertidal habitat, but the Severn Estuary is one of the few places where *S. alveolata* reefs occur extensively in the subtidal, as well as the intertidal. There are patches of intertidal *S. alveolata* reef throughout the Severn Estuary in areas of exposed bedrock or gravel lag, although it tends to be more common on the English side. The subtidal *S. alveolata* tends to be in the outer parts of the Estuary, generally southwest of a line between Clevedon and Newport. Species associated with *S. alveolata* reefs include the polychaetes *Eulalia tripunctata* and *Ampharete acutifrons*, the crustacean *Harpinia pectinata*, the bivalve *Sphenia binghami* and the gastropod *Tricolia pullus* (Mettam *et al*., 1994).

Harder bottom communities become more prevalent in the outer Severn Estuary and Bristol Channel. Benthic surveys have found that from Newport westwards, the Severn Estuary is dominated by the reduced hard bottom community, interspersed with patches of soft bottom community (such as in Bridgwater Bay) and *Modiolus* mussel bed community (to the south and east of Nash Bank) (Warwick and Davies, 1977; Warwick and Uncles, 1980).

Most of these habitats, or sub-categories thereof, are considered Habitats of Principal Importance under the 2006 NERC Act (England), as well as the Environment (Wales) Act 2016. This includes deep muds, subtidal muds sands and gravels, as well as S. *alveolata* and *S. spinulosa* reefs.

Table 8-2 Broad subtidal habitat types described in Mettam (1997)

Habitat Type	Summary
Subtidal mobile or fluid mud	Characterised by the polychaete *N. hombergii*, the cumacean *D. rathkei* and oligochaetes. Typical of Newport Deep and Bridgwater Bay but extending onto lower shores.
Subtidal fine sands, often with mud balls	Characteristic species are the polychaetes *N. cirrosa*, *N. hombergii*, *Arenicola marina*, *Scoloplos armiger* and capitellids. A 'reduced' form is also frequently found, being afaunal or limited to a few capitellids.
Subtidal sand with a very sparse fauna	Often represented by one species and one or two individuals such as the isopod *Eurydice pulchra* and amphipod *Pontocrates*.
Subtidal medium to coarse sand and very low silt	Characterised by small polychaetes including *Macrochaeta* sp. and *Protodiloides chaetifer*. Found throughout the Severn Estuary and Bristol Channel, including the Holm Sands and Nash, becoming generally more impoverished further upstream. Typical of the high energy, mobile sand in the region.
Subtidal muddy gravels and pebbles	This substrate contains a very rich fauna, almost comparable to that found on the *Sabellaria* reef and is found in areas such as the inshore area fronting Cardiff. Species characterising the biotope include *Golfingia* sp., *Melinna cristata, Capitella* sp., *Aricidea minuta, Nereis/ongissima, Mediomastus fragilis,* Oligochaeta, *Harpinia pectinata* and *Nucula* sp., with Anthozoa and Ascidia among the epifauna. A reduced form is also present in the Severn Estuary.
Subtidal *Sabellaria* reef with a variable amount of loose sediment	The biotope is characterised by a relatively diverse fauna of small polychaetes, notably *Eulalia tripunctata* and usually (but not always) *Sabellaria*. It occurs at many sites throughout the region where the sediment is thin enough to expose bedrock or gravel lag. The biotope continues west into the Bristol Channel and extends east to Avonmouth. It is well developed intertidally in the Bristol channel farther west.

8.2.4 Non-native species

The number of invasive non-native species (INNS) in Britain is increasing, principally due to transport via ballast waters and sediments, biofouling and imported consignments of cultured species (Cook *et al*., 2014). A range of initiatives have been established to seek to limit or control the spread and transfer of INNS, including statutory measures such as the Ballast Water Management Convention (BWMC), the EU Regulation 1143/2014 on Invasive Alien Species and the EC Water Framework and Marine Strategy Framework Directives (2000/60/EC and 2008/56/EC respectively) and Schedule 9 Section 14 of the Wildlife and Countryside Act 1981 (as amended).

Within England and Wales, good practice guidance has been developed on how to manage marine biosecurity risks at sites and when undertaking activities through the preparation and implementation of biosecurity plans (Cook *et al*., 2014). Consideration of INNS is now standard practice during operations at marine aggregate production licence areas through the use of the Biosecurity Plan Template and Guidance Document (BMAPA, 2018) and the INNS reporting protocol. It is also worth noting that regulators in both England and Wales have a duty to ensure that the habitats and features of European designated sites are not negatively impacted by the spread of INNS to such sites.

The GB Non-Native Species Secretariat, which holds records of each species in the Species Information Portal, has records for several non-native species in the Severn Estuary and Inner Bristol Channel. Records generally increase to the west of the Severn Estuary along the more open coast of the Outer Bristol Channel. Non-native species that have been recorded around the Severn Estuary include the slipper limpet *Crepidula fornicata*, Jenkins spire shell *Potamopyrgus antipodarum*, sand gaper clam *Mya arenaria*, Australasian barnacle *Elminius modestus*, and the Pacific Oyster *Crassostrea gigas*. The distribution and ecological risk associated with these species in the Severn Estuary is summarised in Table 8-3.

Table 8-3 Non-native marine species recorded in the Severn Estuary

Species	Distribution	Risk/impact
Australasian barnacle *Elminius modestus*	Widespread	Low impact
Slipper limpet *Crepidula fornicata*	Many records along Welsh coast	High impact
Jenkins spire shell *Potamopyrgus antipodarum*	Widespread	Unknown
Pacific oyster *Magallana gigas*	Some records along inner Bristol Channel near border with Severn Estuary, mostly Welsh coast	Medium
Sand gaper clam *Mya arenaria*	Some records, Clevendon to Portishead	Unknown
Common Cord-grass *Spartina anglica*	Widespread	High Impact
Australian Tube Worm *Ficopomatus enigmaticus*	Several records near Cardiff and Bristol	High Impact

Recent advice from NRW (received February 2023 (Scoping Opinion)) has indicated that there are known records of Chinese mitten crab *Eriocheir sinensis* from the Estuary; however, this and species such as the slipper limpet (*Crepidula fornicata*) and Pacific oyster (*Magallana gigas*) are not yet considered established in the Estuary.

8.2.5 Site specific baseline

Both Bedwyn Sands and NMG are predominantly intertidal sand flats, with only very small proportions of these areas being below Chart Datum and thus subtidal (~8% and 2% subtidal sandbanks respectively). The subtidal parts of the Renewal Areas are shallow subtidal sandbanks and constitute the Annex I feature 'sandbanks which are slightly covered by sea water all the time'. The shallow subtidal sandbank biotopes are typically assemblage extensions of the lower intertidal.

As outlined earlier, previous benthic surveys across Bedwyn Sands and NMG have shown that these areas are impoverished in terms of fauna (Henderson *et al*., 2006; Brazier *et al*., 2007; ABPmer, 2015). Studies have indicated that sand moves freely between the sandbank features of the Severn Estuary, driven predominantly by the asymmetry of the tide, and is in a continual state of re-working (e.g. McLaren and Collins, 1989). Over Bedwyn Sands and NMG, work by McLaren and Collins (1989) has shown that where Bedwyn Sands and NMG are located within the Estuary, sediment pathways are classified as 'accretion' or 'equilibrium' (with neither erosion or deposition taking place), as a result of the stronger currents along The Shoots quickly taking material upstream to further areas of deposition (e.g. Dun, Charston and Oldbury Sands) (Figure 8-1).

In line with the RSMP approach, and in support of the marine licence conditions, seabed sampling was carried out at Bedwyn Sands and NMG in 2017 (Ocean Ecology, 2018) and 2020 (Ocean Ecology, 2021). In 2022, a review by ABPmer compared the benthic sampling data collected during 2020 (under the agreed RSMP), against the benthic characterisation survey carried out during Year 1 of the licence term (in 2017) (see ABPmer, 2022a).

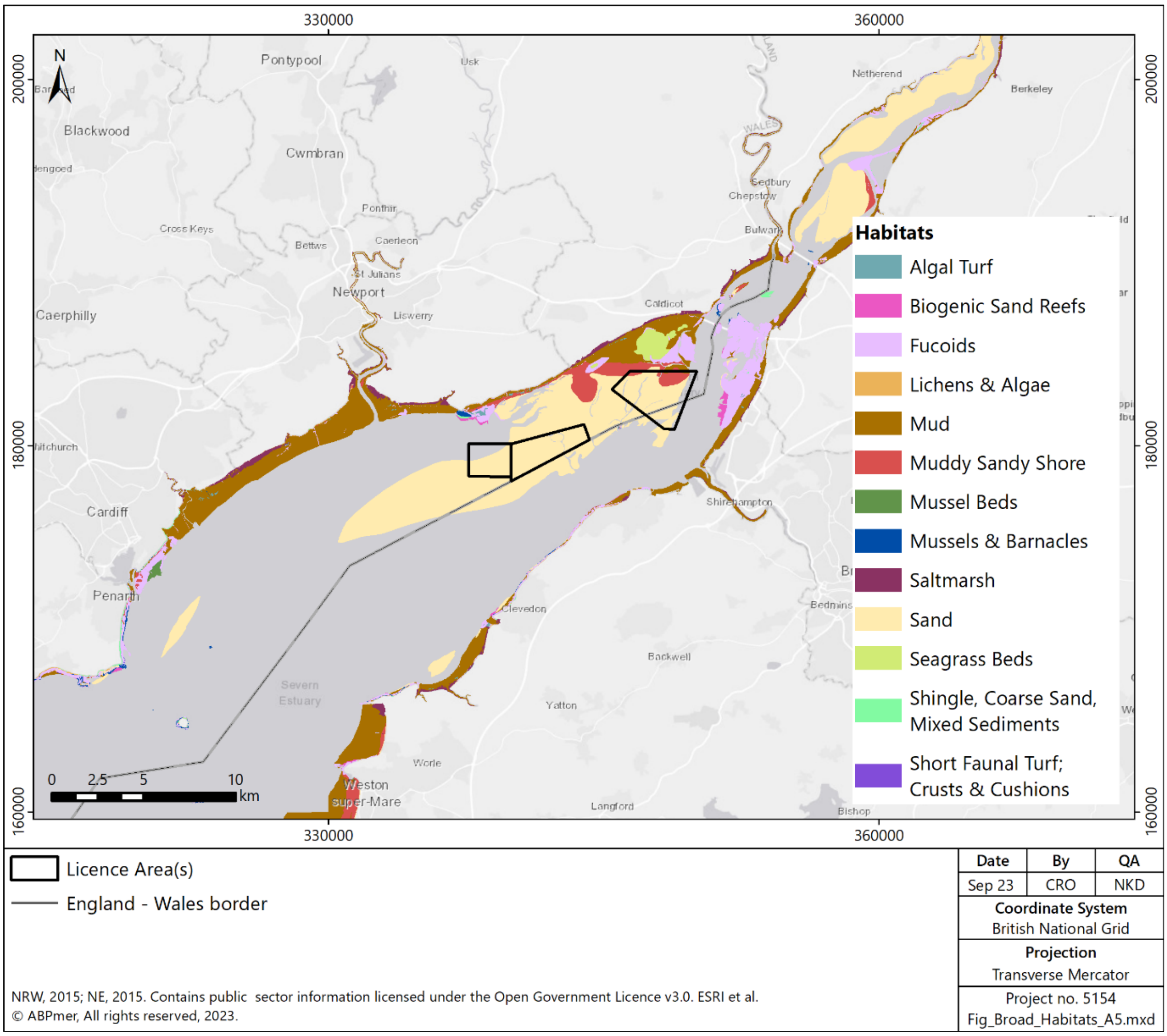

Figure 8-1 Habitat types across the wider Middle and Welsh Grounds

In 2017, a total of 90 grab sampling stations were analysed for both particle size distribution and macrofauna presence and abundance. Of these stations, and as stipulated within the defined RSMP – type sampling plan for MMML1516 (Bedwyn Sands) and MMML160521 (NMG), 21 sampling stations were analysed again in 2020 for macrofauna; these were outside of the Areas at so-called 'context' sites (see ABPmer, 2022a).

During the baseline characterisation study in 2017, 42% of the stations had a total macrofaunal abundance of zero or one, with 16 stations having no macrofauna present. Equally, some taxonomic classes were only present in one or two stations. Macrofauna recorded were Nematodes, polychaetes *Sabellaria alveolata* and *Streblospio* sp., barnacles *Austrominius modestus* and *Amphibalanus improvisus*, and the mudsnail *Peringia ulvae*. In addition, the wider area also had species such as the amphipod *Bathyporeia pelagica,* and polychaete *Mediomastus fragilis*.

In 2020, the only grab sample stations which displayed any notable changes in community structure and abundance were limited to those outside the Renewal Areas. No invasive non-native species were recorded within the 2017 and 2020 benthic surveys (ABPmer, 2022a).

The results from 2017 and 2020 support the results from earlier survey programmes (see ABPmer, 2017), indicating that the Renewal Areas are highly impoverished with very low numbers of benthic fauna recorded (richness and abundance).

The homogenous nature of the Renewal Areas means that they are comprised of just several biotopes all of which are common within the Estuary.

Biotopes present at Bedwyn Sands:

- LS.LSa.FiSa.Po (EUNIS A2.231)[7]'Polychaetes in littoral fine sand';
- LS.LSa.MoSa.AmSco (EUNIS A2.223) 'Amphipods and *Scolelepis* spp. in littoral medium-fine sand';
- LS.LSa.MoSa.BarSa (EUNIS A2.221) 'Barren littoral coarse sand'; and
- LS.LMu.MEst.HedLim (EUNIS A2.312) '*H.diversicolor* and *Limecola balthica* in littoral sandy mud'.

Biotopes present at NMG:

- LS.LSa.FiSa.Po (EUNIS A2.231) 'Polychaetes in littoral fine sand';
- LS.LSa.MoSa.AmSco (EUNIS A2.223) 'Amphipods and *Scolelepis* spp. in littoral medium-fine sand'; and
- LS.LSa.MoSa.AmSco.Eur (EUNIS A2.2232) '*E. pulchra* in littoral mobile sand'.

The mobile sand biotopes at both Renewal Areas extending into the shallow subtidal with the barren littoral coarse sand biotope thought to constitute the subtidal at Bedwyn Sands (see Brazier *et al.*, 2007).

Species and habitats of importance

As outlined in Section 5 and 8.2, the extremely strong currents experienced throughout the Renewal Areas and the highly dynamic substrata do not provide suitable conditions for colonisation beyond the short term. he Renewal Areas encompass the Annex 1 features 'sandbanks which are slightly covered by sea water all the time' and 'mudflats and sandflats not covered by seawater at low tide'. However, the very mobile nature of the sediments across these areas results in highly impoverished habitats.

Bedwyn Sands

With the exception of subtidal sands and gravels (which occupy around 8%), no other species or biotopes considered nationally rare or important, such as *S. alveolata* reefs or eelgrass beds have been recorded at Bedwyn Sands in any of the surveys undertaken in the area (e.g. Mettam, 1997; Wyn *et al.*, 2000; Henderson *et al.*, 2006; Brazier *et al.*, 2007). The nearest patch of eelgrass recorded in the NRW biotope survey was over 500 m from the Bedwyn Sands SIZ (Brazier *et al.*, 2007), towards West Pill (see Figure 8-1). NRW hold one point sample with *Sabellaria* against the habitat description in the vicinity of this Renewal Area. This survey record from 2011 is located east of the Renewal Area outside of the SIZ. However, it should also be noted that *S. alveolata* is not listed in the species list for this sample and NRW recorded low confidence in the reliability of this record.

North Middle Ground

As with Bedwyn Sands, with the exception of subtidal sands and gravels (which occupy around 2%) no other species or biotopes considered nationally rare or important have been recorded at NMG in any of the surveys undertaken in the area (e.g. Mettam, 1997; Wyn *et al.*, 2000; Henderson *et al.*, 2006; Brazier

7 Habitat classifications shown are in line with the JNCC Marine Habitat Classification for Britain and Ireland (JNCC, 2022), as well as the Europe-wide EUNIS system (European Nature Information System).

et al., 2007). For example, the nearest patch of eelgrass is >1 km from the NMG SIZ (see Brazier *et al*., 2007) (Figure 8-1). Given the unstable and highly dynamic nature of the substrata the paucity of benthic communities is not unsurprising.

8.3 Impact assessment

Dredging within Bedwyn Sands and NMG has the potential to affect benthic habitats and species through the following activities and sources:

- **Draghead**: The direct removal of seabed by the draghead can result in the loss of and/or damage to benthic habitat (biotope), a change in the nature of the seabed, and removal of reproductive faunal populations. These effects could have indirect impacts on predators. Bathymetric changes could result in changes in the sediment flux and could potentially affect the range of benthic species; and
- **Overspill**: At high levels, suspended sediment plumes and associated sediment deposition could affect filter feeders and the survival of pelagic eggs and larvae of fish. Plumes could also have positive effects, both with respect to providing an additional food resource (i.e. organic content) for filter and surface deposit feeders and tube building material for some polychaetes. The pathway has a zone of influence with effects being most prevalent at the source and diminishing with distance (mostly <150 m from the source, as determined through modelling);
- **Screening**: This will result in the same, albeit more localised, effects as the overspill with regard to the plume (see above). Furthermore, bedform and seabed sediment changes could result due to the unwanted sediment being returned. Where sand is screened, then the dispersion of sand can locally alter the nature of the bed sediment, making it finer and potentially altering the benthic communities where these changes occur; effects are typically observed in close proximity to the screening vessels, but, have been observed as far as 2 to 2.5 km away under strong net transport conditions.

Impact pathways not included in the assessment: No pathways have been scoped out of this assessment.

With regard to receptors, intertidal benthic features and habitats (including saltmarsh) outside of the study area are not considered further in the assessment as the predicted scale of change caused by the dredging activity is not expected to cause any potential impacts to these receptors (see Section 5).

This assessment considers benthic fauna and habitats, with the exception of fish (including demersal fish and shellfish), the latter of which are covered in Section 9.

Impact pathways included in the assessment: The key impact pathways relating to benthic species and habitats are the following:

- Potential impacts to benthic species and habitat receptors from seabed removal (Section 8.3.1);
- Potential impacts to benthic species and habitat receptors due to the suspended sediment plume (Section 8.3.2);
- Potential impacts to benthic species and habitat receptors due to fine sand deposition and dispersion (including bedform) (Section 8.3.3);
- Potential impacts to benthic species and habitat receptors due to bathymetric changes (including sediment flux) following dredging (Section 8.3.4);
- Potential disturbance of benthic invertebrate receptors due to noise (Section 8.3.5); and
- Potential impacts to benthic species and habitat receptors due to the introduction of non-native species (Section 8.3.6).

Benthic features, intertidal species and habitats (including saltmarsh) outside of the SIZs are not considered further in the assessment, as the predicted scale of change caused by the dredging activity is not expected to cause any potential impacts to these receptors (see Section 4.1). Similarly, eelgrass beds are all beyond the SIZ, the nearest being >500 m to the north of the Bedwyn Sands SIZ, noting that the northern part of the Bedwyn Sands Renewal Area is also an exclusion zone to dredging operations. Hence, eelgrass beds are beyond the localised worst-case footprints for the sediment plume (see Section 4.1) and are not considered further. This assessment considers benthic fauna and habitats, with the exception of fish (including demersal fish) (see Section 9), recorded within the SIZ of the Renewal Areas.

The assessment envelope for this impact assessment can be found in Section 3.4 (dredging programme). To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied to determine the significance of effects (Section 4).

With regard to the different assessment criteria, for benthic habitats and species, magnitude will very much depend on the given pathway, and thus magnitude is set out in each pathway assessment section below. The benthic habitats and species within the Renewal Areas and their SIZs have varying sensitivity to the different impact pathways, and these are thus also set out in each of the assessment sections below with reference to the Marine Life Information Network (MarLIN) Marine Evidence based Sensitivity Assessments (MarESAs).

The importance of the benthic habitats and species present in the Renewal Areas and their impact zones range from medium to high (see Table 8-4 for more detail).

Table 8-4 Importance of benthic receptors

Receptor	Importance	Rationale
Intertidal mud and sandflats	Moderate	Article 17. Intertidal mudflats also Section 7/OSPAR/NERC, but Renewal Areas dominated by sandflats. Widespread and low diversity
Subtidal sandbanks	Moderate	Article 17. Widespread and low diversity
Subtidal sands and gravels	Moderate	Subtidal sands and gravels are Section 7/NERC habitats, noting that Renewal Areas dominated by intertidal sandflats, and only 8% and 2% subtidal (Bedwyn Sands and NMG respectively)
S. alveolata reefs	High	Article 17 and Section 7/ NERC/OSPAR. High diversity

Whilst comparatively low numbers of *Sabellaria* individuals have been found within the PIZ (Ocean Ecology, 2018), no reefs were identified. As a precautionary approach, *Sabellaria* reefs have been assessed given their potential to exist in the wider area. However, given the highly dynamic environment existing within the Renewal Areas it is considered unlikely that reef features could establish. 7

8.3.1 Potential impacts to benthic species and habitat receptors from seabed removal

General scientific context

The main impact of marine aggregate extraction relates to the direct removal of seabed sand and gravel; this removes benthic species and habitats that live on or within the sediment extracted. Previous research has suggested that this can result in a 40 to 95% reduction in the number and biomass of organisms, and a 30 to 70% reduction in the number of species present (Newell *et al.,* 1998). Seabed removal can therefore result in a change to benthic biotopes and their associated fauna and can impact prey/food items available to higher trophic organisms (Moulaert *et al.,* 2005). Removal of organisms, however, is restricted to areas where dredging occurs, and the higher the dredging intensity is, the more pronounced the impact (Boyd and Rees, 2003).

Individuals entrained are not necessarily killed. Some may survive the entrainment process and be returned to the sea in outwash or during screening. The proportion of individuals that escape, and their subsequent survival rate, is not known (Tillin *et al.,* 2011). Additionally, some mobile epifauna may have the ability to avoid entrainment by moving away from the head.

The recoverability of benthic resources following the cessation of dredging is influenced by several environmental factors including sediment type and hydrodynamics (e.g. Foden *et al.,* 2009). Generally, it occurs faster in unstable dynamic environments such as shallow water mobile sands where typical recovery times range from a few months to two to four years. Conversely, for stable environments, such as deep-water stable gravels, recovery can take up to 15 years due to the presence of long-lived species (Tillin *et al.,* 2011).

Rates of recolonization and recovery of benthic communities generally conform to the well-known principles of ecological succession. Sites are initially colonised by short-lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly polychaetes worms. In time, these are succeeded by longer-lived, slower growing species with a lower tolerance for disturbance (Newell *et al.,* 1998; Hill *et al.,* 2011; Barrio Froján *et al.,* 2011). However, in dynamic environments, such as the Renewal Areas, opportunistic species are often dominant in un-dredged areas (e.g. Cooper *et al.,* 2007), reflecting the prevailing regime of ongoing natural disturbance.

Impact assessment

The fauna associated with the material that is to be removed by the dredging process may be injured or killed, and habitats could theoretically be lost, albeit acknowledging that all the habitats present within the Renewal Areas are widespread in the Estuary. Furthermore, the natural changes experienced on these areas as a result of coastal processes and sediment transport, means these habitats have been historically and regularly impacted by the natural environment.

The assessment of this pathway is split into two receptor groups; 'general benthic habitats and species', (covering 'intertidal mudflats and sandflats' and 'subtidal sandbanks'), and '*S. alveolata* reefs'. Noting that the only protected features recorded within the proposed dredging areas within Bedwyn Sands and NMG are intertidal sandflats and subtidal sandbanks, as well as subtidal sands and gravels. While muddy habitats exist in the northern part of Bedwyn Sands, these are located within the exclusion zone (see Section 3.5.2).

Whilst undertaking these assessments, best practice procedures as outlined in Section 3.5 have been taken into account.

These were outlined in Section 3.5 and include most notably:

- Regular monitoring in line with the RSMP approach;
- Leaving the seabed sediments post-dredging in a similar physical condition to that present before dredging;
- Further zoning of licensed areas to delineate ADAs, reducing the area affected by seabed removal; and
- Not dredging sediments down to bedrock but leaving an adequate depth of suitable material (normally an average of 0.5 m). Thus, there is no long-term habitat loss.

General benthic habitats and species

The Renewal Areas (PIZ) and the SIZs predominantly consist of highly impoverished mobile clean sand habitat with almost no benthic fauna recorded (e.g. Henderson *et al*., 2006; Brazier *et al*., 2007; ABPmer, 2022b) (see Section 8.2). The community present consists of species well adapted to living in a dynamic and disturbed tide-swept environment. These disturbance-tolerant species have high recoverability rates and are capable of rapidly recolonising disturbed habitat (e.g. Budd, 2006; Budd and Curtis 2007; Budd and Hughes, 2005).

The duration of the impact associated with dredging in the Renewal Areas is considered intermediate (throughout the duration of the 15-year licence period) as it will be intermittent in nature, resulting in a medium probability of occurrence.

A relatively small spatial extent of the seabed (and the biotopes present) would be affected by dredging in the areas (in the context of the widespread nature of these habitats in the region). Both Renewal Areas have been dredged previously and as the communities present are subject to natural high levels of disturbance through the hydrodynamic processes exhibited in the Estuary, will recolonise in the short term. Thus, a small magnitude of change is assigned resulting in a low exposure to change. The Annex I features 'intertidal mudflats and sandflats' and 'subtidal sandbanks' are common and widespread throughout the region, as are the biotopes recorded across the Renewal Areas (Section 8.2) that are encompassed by these Annex I features. Against the pressure 'habitat structure changes – removal of substratum' the MarESA assigns a medium sensitivity to all biotopes recorded in the Renewal Areas (Tillin and Budd, 2016; Ashley, 2016; Tillin, 2016; Tillin *et al*., 2023). The medium sensitivity from MarESA translates to a sensitivity of 'moderate' as used within the EIA methodology for this ES. For other relevant pressures relating to this potential impact (i.e. 'abrasion/disturbance of the surface of the substratum or seabed' and 'penetration or disturbance of the substratum subsurface'), a sensitivity of 'low' is assigned to all biotopes (Tillin and Budd, 2016; Ashley, 2016; Tillin, 2016; Tillin *et al*., 2023).

Combining a low exposure to change to a moderate sensitivity, results in a vulnerability assessment of 'low' (see Section 4.4.3). As the benthic features are assessed as moderate importance (see Table 8-4), impacts are **minor adverse**. Acknowledging the best practice procedures (Section 3.5), the residual impact significance is assessed as **minor adverse**.

Sabellaria reefs

As outlined in the baseline section, *Sabellaria alveaolata* reefs are present within the wider Estuary, however, these have not been recorded within the Renewal Areas or SIZs.

It is considered that *Sabellaria alveolata* aggregations in such a highly dynamic environment would be best considered as naturally ephemeral features, should they ever be found to occur within the Renewal Areas.

The high conservation importance *Sabellaria* reefs and their sensitivity to direct removal is acknowledged. However, given that they have not been recorded within the Renewal Areas or SIZ's the probability of occurrence is low. The probability of occurrence is reduced to negligible considering the best practice procedures (namely monitoring through LiDAR and implementation of zoning) allowing reef features to be identified and avoided. Typically, exclusion zones incorporate the mapped potential reef feature(s), as well as a 50 m buffer around the boundary of these features.

Acknowledging that the probability of occurrence would be negligible with the implementation of the best practice procedures, consequently the impact significance is assessed as **insignificant**.

8.3.2 Potential impacts to benthic species and habitat receptors due to suspended sediment plume

General scientific context

Dredging activities result in the suspension of disturbed sediment and subsequent deposition of material (mostly by screening and overspill) (Newell *et al.,* 1998). Whilst coarser sediments will be returned to the bed (see Section 8.3.3 for assessment of related impacts), finer materials are likely to stay in suspension and form a plume. This can lead to rapid, temporary, changes in turbidity, as well as temporary siltation at the bed.

Increased turbidity and temporary siltation may lead to the gills of suspension feeders (grazing on suspended organic matter i.e. bivalves) becoming clogged and favour the development of deposit feeders (that graze on settling organic matter i.e. polychaetes). However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions, reducing their sensitivity to the impact. The negative effects of increased suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects. However, this is generally thought to be of less concern where fauna is adapted to naturally high levels of suspended sediments (Boyd *et al.,* 2004).

With regard to *Sabellaria* reefs, the potential impacts from sediment plumes and sediment deposition are not thought to be entirely detrimental (Last *et al.,* 2011). Some degree of sediment transport is indeed essential for *Sabellaria* sp. to build their tubes. On specimens exposed to higher turbidity in the water column (increased suspended particulate matter), Last *et al.* (2011) reported that some individuals showed significantly higher tube growth than at lower suspended particulate levels. However, other individuals did not respond with increased rates of tube-building (Last *et al.*, 2011). This suggests that *Sabellaria* sp. is able to tolerate and respond to elevated suspended sediments concentrations though not all individuals may respond positively. An increase in siltation may temporarily (at worst for a few hours) clog feeding apparatus (Jackson and Hiscock, 2008) and, therefore, there is the potential for this feature to be negatively impacted in the immediate vicinity to dredging activity, where turbidity is substantially increased.

Impact assessment

The assessment of this pathway is split into two receptor groups; 'general benthic habitats and species', (covering 'intertidal mudflats and sandflats' and 'subtidal sandbanks'), and '*S. alveolata* reefs'.

Whilst undertaking these assessments, best practice procedures as outlined in Section 3.5, have been taken into account.

Concentrations of suspended sediments >500 mg/l have been reported from the Severn Estuary on occasions (Kirby, 1986; 2010). Due to the predominant sediment type at the Renewal Areas being sand, it is highly unlikely that dredging operations would lead to any notable increase in SSC.

Acknowledging the proposed activities, the sandy substrata and the surrounding environmental conditions, Section 6.3 concluded that the impact of the suspended sediment plume is **insignificant** on water quality. This conclusion is considered within the subsequent assessments below.

General benthic habitats and species

Increases in suspended sediment concentrations (SSC) have the potential to disturb, or even kill benthic species, and may alter the benthic community structure of the area.

The predicted increases in SSC will only occur during dredging operations and will tend to dissipate to natural background levels within a few hours after the cessation of dredging (see also Section 6.3.1). Therefore, increases in SSCs will only be experienced for a few hours at most over a 24-to-36-hour dredging cycle (Emu, 2012). Even when these temporary concentration increases occur, they will generally be of a similar magnitude to those which can occur naturally within the Estuary. Furthermore, the worst-case footprints of the plume are localised (restricted to the SIZ as a worst case) and as noted in Section 6.3, the predicted increases in SSC, will be temporary and of a similar magnitude to those which occur naturally.

Thus, in physical terms, the plumes resulting from proposed dredging will have a minimal effect on SSC around the Renewal Areas and a magnitude of change of negligible is assigned against a probability of occurrence of medium, resulting in a negligible exposure to change.

The Annex I features 'intertidal mudflats and sandflats' and 'subtidal sandbanks' are common and widespread throughout the region as are the biotopes recorded across the Renewal Areas that are encompassed by these Annex I features (Section 8.2.5). Because of the natural sediment mobility in the Severn Estuary, the biotopes and species present are well adapted to turbid conditions. Given the low sensitivity of all recorded biotopes to the pressures associated with this impact (see Tillin and Budd, 2016; Ashley, 2016; Tillin, 2016; Tillin *et al*., 2023) and the negligible exposure to change, a vulnerability of 'none' is assigned resulting in an impact significance of '**insignificant**' being assessed.

Sabellaria reefs

Sabellaria alveolata reefs, if there were to be present, are not considered to be particularly sensitive to this pathway. They have been assigned by MarESA a sensitivity of 'medium' and 'not sensitive' respectively, with regard to the pressures 'changes in suspended solids' and 'smothering and siltation changes (low)' (see Tillin, 2015). However, as detailed above, a magnitude of change of negligible is assigned, along with a probability of occurrence of low, given that *Sabellaria* reefs have not been recorded within the SIZ. This results in a negligible exposure to change and thus a vulnerability of 'none' is assigned; resulting in an impact significance of '**insignificant**' being assessed.

Furthermore, acknowledging the best practice procedures would reduce the probability of occurrence to negligible.

8.3.3 Potential impacts to benthic species and habitat receptors due to sediment deposition and dispersal (including bedform)

General scientific context

Fine sand dispersion results from transport of sand under the influence of tidal currents. The spatial extent of fine sand dispersion can be among the largest footprints of all aggregate extraction effects (although not in the Severn Estuary, see Section 4.1). Where sand is screened, then the dispersion of sand may locally alter the nature of the bed sediment, making it finer and potentially altering the benthic communities where these changes occur. Where a lot of sand is screened, relatively deep deposits could form under the dredger, smothering benthic habitats and species, and bedforms could form; this is more likely during neap tides when sediment mobility rates are at their least.

The effects of fine sand dispersion have implications for changes in the rate of sediment oxygenation by seawater percolation. A layer of fine particles or infilling of sediment pore (interstitial) spaces by fine particles will reduce water flow rates into sediments. This affects oxygen availability for benthic infauna, and also potential for affecting faunal motility and prey availability within sediments. Epibenthic sessile and encrusting fauna may furthermore be significantly impacted by deposited fine sand due to smothering. If the amount of sediment deposited is too great to allow species to survive burial, then recovery occurs via re-colonisation and/or immigration to the new sediment surface (Bolam *et al*., 2006a; 2006b).

Highly mobile subtidal sands and intertidal sandflats are not considered sensitive (high resistance and high resilience) to the deposition of 5 cm of fine material in a single event (Tillin *et al*., 2010). The sensitivity assessments available on the Marine Life Information Network (MarLIN) website indicate that clean sandy shores have a low sensitivity to smothering as although the deposition of 5 cm of sediment would cover the tubes of amphipods and prevent suspension feeding, they are considered able to burrow through the sediment and recover almost immediately (Budd, 2006; Rayment, 2002). Further consideration of the sensitivities of recorded biotopes to smothering is detailed below.

Impact assessment

The assessment of this pathway is split into two receptor groups; 'general benthic habitats and species', (covering 'intertidal mudflats and sandflats' and 'subtidal sandbanks'), and '*S. alveolata* reefs'.

Whilst undertaking these assessments, best practice procedures as outlined in Section 3.5, have been taken into account.

As mentioned previously, work by McLaren and Collins (1989) has shown that where Bedwyn Sands and NMG are located within the Estuary, sediment pathways are classified as 'accretion' or 'equilibrium'. Thus, indicating that deposition of sediment (and therefore replenishment of the Renewal Areas) is an ongoing process experienced by the temporary benthic communities that exist in these locations. Furthermore, at Bedwyn Sands and NMG, in effect, the resource is well sorted sand, with very little gravel. Thus, Breedon Group targets sand at these Areas and only screens gravel, rejecting only around 3% (maximum) of the dredged material (see Section 3.3).

General benthic habitats and species

The majority of the Renewal Areas are intertidal and consist of tide swept sandflats with changes in mobile bedform features such as mega-ripples frequently occurring as a result of the highly energetic tidal processes occurring in the area. This results in regularly changes in deposition and sediment depths. Similarly, the shallow subtidal sandbanks that exist along the edges of the Renewal Areas are even more prone to the strong currents and thus represent naturally highly dynamic features with regular deposition of material occurring.

Deposition of sediment as a result of intermittent dredging will be highly localised (restricted as a worst case to the SIZ). In addition, any sediment that settles will not be measurable against background variability and will be rapidly re-dispersed by ambient tidal currents within a very short period of time (see Section 5.2). Gravel will fall generally fall out within the PIZ, and only a small percentage of the material is returned, as noted above.

The magnitude of the change is therefore considered to be small and probability of occurrence low. This results in an exposure to change of negligible.

The benthic assemblage recorded in the study area is highly impoverished. Those species which are present are well adapted to dynamic sand environments and are considered tolerant to the level of sand or gravel deposition occurring as a result of dredging (which is in the range of variability found naturally in the study area). For the biotopes recorded within the Renewal Areas and SIZs, the MarESA sensitivities related to the pressure most relevant to this potential impact, 'smothering and siltation rate changes (heavy, up to 30 cm), range from 'not sensitive' to 'low' (see Tillin and Budd, 2016; Ashley, 2016; Tillin, 2016; Tillin *et al.*, 2023). This results in a vulnerability of none when assigned against a negligible exposure to change.

Given the importance of these benthic features are assigned as moderate (see Table 8.4), results in the potential impact being assessed as **'insignificant'**.

Sabellaria reefs

Sabellaria alveolata reefs, if there were to be present, have been assigned by MarESA a sensitivity of 'medium' with regard to the pressure 'smothering and siltation changes (heavy)' (see Tillin, 2015). However, given that *Sabellaria* reefs have not been recorded within the SIZ, a magnitude of change of negligible is assigned, along with a low probability of occurrence. This results in a negligible exposure to change and thus a vulnerability of 'none' is assigned; resulting in an impact significance of '**insignificant**' being assessed.

Furthermore, acknowledging the best practice procedures would reduce the probability of occurrence to negligible.

8.3.4 Potential impacts to benthic species and habitat receptors due to bathymetric changes (including sediment flux)

General scientific context

Dredging can cause indirect bathymetric changes linked to modifications in physical process such as accretion and bed disturbance (Bradbury *et al.,* 2003). Furthermore, dredging itself lowers the seabed, as outlined in Section 4.1.

At Bedwyn Sands and NMG, if the whole resource were to be removed, then lowering of up to 0.52 m and 0.31 m respectively could take place across the areas (noting that the average bed lowering applied for the CIS includes a 10% uplift on total extraction volumes for added conservatism) (ABPmer 2023).

Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges of physiological stresses caused by exposure and tidal elevation. This can lead to zonation (Peterson, 1991). Therefore, bathymetric changes caused by dredging could change the vertical distribution of marine habitats and affect biotopes if post-dredging water depths were outside the range at which specific biotopes exist.

Impact assessment

Section 5.3 concluded that any effect on bed levels arising from the proposed dredging activity at the Renewal Areas will be limited in duration (given the rapid recovery rates), and small in magnitude, when compared against the natural variability exhibited by the banks across the wider study area.

Benthic habitats and species (including Sabellaria reefs)

The tide-swept mobile sediment habitats present at the Renewal Areas are subject to persistent physical disturbance through natural sand movements. This disturbance causes regular elevation changes which are often linked to shifting morphological features such as sand waves and creeks. These elevation changes cause little change to the impoverished faunal assemblage found in these locations (ABPmer, 2014).

Changes to the depth of the seabed as a result of the proposed continued dredging are considered to be small in relation to the natural variability, and very short-lived in duration (Section 5). Depth changes are therefore not expected to affect species range or change habitats. Therefore, whilst the probability of small bathymetric changes is high, magnitude of change is negligible. Consequently, the potential impact is assessed as '**insignificant**' for all benthic features.

8.3.5 Potential disturbance of benthic invertebrate receptors due to noise

General scientific context

Noise disturbance in the water column and on the seabed is known to increase as a result of aggregate extraction (e.g. Tillin *et al.,* 2011). The implications of increased noise disturbance on invertebrates are difficult to assess, as studies on hearing in invertebrates are limited (Cefas, 2009). It appears likely that most invertebrates can only experience the sound wave as a physical force (Tasker *et al.,* 2010). Several recent studies have revealed a range of negative effects from noise which demonstrate that there is a potential for benthic invertebrates to be significantly impacted by noise and vibration. Wale *et al.* (2013) conducted a series of controlled tank-based experiments to consider how playback of ship noise, affects foraging and antipredator behaviour in the shore crab, *Carcinus maenas*. Ship noise playback was found to be more likely than ambient-noise playback to disrupt feeding, although crabs experiencing the two sound treatments did not differ in their likelihood of, or speed at, finding a food source in the first place. Ship noise playback resulted in a slower retreat to shelter and slower righting (where crabs had been turned on their backs); this led the researchers to conclude that anthropogenic noise had the potential to increase the risks of starvation and predation.

Solan *et al.* (2016) investigated whether exposure to Continuous Broadband Noise (CBN) and Impulsive Broadband Noise (IBN) affects the physiology and behaviour of three representative and functionally important benthic invertebrate species (the clam, *Ruditapes philippinarum*; the decapod, *Nephrops norvegicus*; and the brittlestar, *Amphiura filiformis*). The authors demonstrated, for invertebrate species that do not rely on acoustics for communication, that exposure to fully constrained sources of sound can result in behavioural responses that alter how species mediate ecosystem processes known to be key determinants of functioning.

Furthermore, differences in sound field characteristics were observed to elicit different response patterns that appeared to be proportional to the type of anthropogenic sound field that was encountered. For *N. norvegicus*, the addition of either anthropogenic sound source repressed burying and bioirrigation behaviour and considerably reduced locomotion activity. For *R. philippinarum*, a typical stress response was reduced surface relocation activity, move to a position above the sediment-water interface, and valve closure. No statistically verifiable similar changes in behaviour were observed for *A. filiformis*. However, the authors cautioned that this did not mean that this species was unaffected by exposure to anthropogenic sound. This is because closer examination of the data revealed that exposure to sound compromised physiological processes in a number of individuals (indicated by increased variability in response) that, in turn, corresponded to increased variability in some, but not all, aspects of bioturbation behaviour.

There is increasing evidence to suggest that benthic invertebrates respond to sediment vibration. For example, blue mussels *M. edulis* vary valve gape, oxygen demand and clearance rates and hermit crabs *Paganus bernhardus* shift their shell and, at very high amplitudes, leave their shell, examine it and then return. The vibration levels at which these responses were observed generally correspond to levels measured near anthropogenic operations such as pile driving and up to 300 m from explosives testing (blasting) (Roberts *et al.,* 2016). A range of behavioural effects have also been recorded in decapod crustaceans, including a change in locomotion activity, reduction in antipredator behaviour and change in foraging habits (Tidau and Briffa, 2016).

Impact assessment

With regard to magnitude of change, it should be noted that the source noise levels associated with aggregate extraction are relatively modest compared to many construction activities in the marine environment and are characteristic of levels associated with general shipping activity (see also Section 11.3).

Benthic habitats and species (including Sabellaria reefs)

On the basis that benthic invertebrates will not be exposed to a large change in noise levels and that changes will not be continuous, a negligible exposure level is assessed. With regard to sensitivity, all the MarESA habitat assessments assign 'not relevant' for the pressure 'underwater noise changes' to the biotopes located within the SIZs and also to *Sabellaria* reefs, as recorded within the wider study area beyond the SIZs (see Tillin, 2015; Tillin and Budd, 2016; Ashley, 2016; Tillin, 2016; Tillin *et al*., 2023).

Thus, the potential impact of noise disturbance on these features is **insignificant**.

8.3.6 Potential impacts through the introduction and spread of non-native species.

General scientific context

The number of invasive non-native species (INNS) in Britain is increasing, principally due to transport via ballast water and sediments, biofouling and imported consignments of cultured species (Cook *et al.*, 2014). A range of initiatives have been established to seek to limit or control the spread and transfer of INNS, including statutory measures such as the Ballast Water Management Convention (BWMC), the EU Regulation 1143/2014 on Invasive Alien Species and the EC Water Framework and Marine Strategy Framework Directives (2000/60/EC and 2008/56/EC respectively). Within England and Wales, good practice guidance has been developed on how to manage marine biosecurity risks at sites and when undertaking activities through the preparation and implementation of biosecurity plans (Cook *et al.*, 2014). It is also worth noting that regulators in both England and Wales have a duty to ensure that the habitats and features of European designated sites are not negatively impacted by the spread of INNS to such sites.

Marine non-native species typically have three main vectors by which they can spread from one location to another, specifically, biofouling, transfer in water and transfer within the sediments (either dredged or taken on-board with vessel water). With regard to aggregate dredging, the following possible pathways exist (BMAPA, 2018):

- Ballast water;
- Ballast sediment;
- Hopper water;
- Biofouling;
- Residual cargoes;
- Hopper washing; and
- Spoilt cargoes.

Beach nourishment projects are not considered to be a pathway which needs to be addressed for the licencing of marine aggregates dredging *per se*, as it is assumed that such projects would always be accompanied by a project-specific EIA and INNS risk assessment. It should be noted that hopper washing is not proposed (see Section 3.3).

Impact assessment

Consideration of INNS is now standard practice during operations at marine aggregate production licence areas through the use of the Biosecurity Plan Template and Guidance Document (BMAPA, 2018) and the INNS reporting protocol.

For the Renewal Areas, the risk of INNS introduction is small. This is because the dredging vessel(s) will be restricted to inshore movements between the Renewal Areas and unloading areas (primarily at Newport but also Chepstow and Avonmouth). The increased risk of the spread of INNS from one unloading port to another and from between the unloading areas and the Renewal Areas is small given that the INNS identified are widespread throughout the Severn Estuary. Localised movements of boats in the coastal zone are considered to have a much lower risk of introducing and spreading non-native species than large, ocean-going vessels which travel large distances.

It is also acknowledged that the mobile sandflat and subtidal sandbank habitats found across the Renewal Areas do not provide suitable habitat for colonisation of any of the INNS currently recorded in the Severn Estuary.

Consequently, the probability of occurrence of the introduction and spread of INNS from the proposed dredging activities at these locations is low and the magnitude of change small, thus resulting in a negligible exposure to change. Hence, the potential impact of INNS on benthic receptors at the Renewal Areas is assessed as **'insignificant'**.

8.4 Summary and conclusions

Table 8-5 summarises the impact assessment judgements and conclusions and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 8-5 Benthic species and habitats impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Exposure of relevant benthic features to impacts from the dredging ranges from negligible to small based on varying probabilities of occurrence and magnitudes of change. The highest values are assigned for the potential impacts of 'seabed removal'.
Estimation of vulnerability	Vulnerability ranged from none to low, depending on the sensitivity of the feature. The highest values being assigned for the 'seabed removal' a impact.
Estimation of significance	Most impact pathways were assessed as insignificant; this is with the exception of 'seabed removal' and the general assemblage, which was assessed as minor adverse. Acknowledgement is given to the best practice procedures (Section 3.5).
Conclusion	Data indicates that the benthic assemblage found in the study area is highly impoverished. Due to the highly localised and small-scale changes predicted as part of the dredging, which are considered to be within the natural variability of the Estuary, impacts are assessed as **minor adverse** at worst.
Confidence Assessment	There is a wide range of data on the presence of marine species and habitats within the Severn Estuary and the study area. In addition, peer reviewed information is available on the susceptibility and sensitivity of the relevant benthic features to the direct and indirect impacts of dredging (e.g. MarESA[8]). Confidence was therefore assessed as **high**.

[8] Marine Evidence based Sensitivity Assessment (MarESA) - summary - MarLIN - The Marine Life Information Network https://www.marlin.ac.uk/sensitivity/sensitivity_rationale

8.5 References

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9 Fish and Shellfish

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on fish and shellfish. Section 9.1 outlines the data sources and consultation used to inform the baseline and assessment. The subsequent two sub-sections (Sections 9.2 and 9.3) cover the baseline and impact assessment relating to these receptors, and Section 9.4 provides a brief conclusion.

It should be noted that this this section considers potential effects on fish and commercially important shellfish species. Potential effects on infauna and epifaunal benthic species more generally are considered within Chapter 8 (benthic habitats and species). Fisheries (both finfish and shellfish) are covered in Chapter 12.

9.1 Data sources and consultation

9.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- Area 531 Environmental Statement (ABPmer, 2019);
- North Middle Ground Environmental Statement (ABPmer, 2016);
- Bedwyn Sands Environmental Statement (ABPmer, 2015);
- CCW Severn Estuary Fish Review (Bird, 2008);
- Cefas Benthic and Fish Surveys of NMG:(HR Wallingford, 2003);
- NRW/Environment Agency Water Transitional and Coastal Water Bodies (TraC) Fish Monitoring: the results of ongoing annual WFD fish monitoring;
- Monitoring of Fish and Crustacean Species at Hinkley: Long term monitoring results of fish captured on the intake screens of Hinkley Point 'B' power station (Henderson *et al.*, 2011; Henderson *et al.*, 2007; Henderson *et al.*, 2006; Cefas, 2022);
- Fish and Macro-crustacean Communities and their dynamics in the Severn Estuary. Summary review paper primarily focusing on the results of long-term monitoring of fish entrained on the cooling water intake screens at Hinkley Point and Oldbury power station (Henderson and Bird, 2010);
- CCW Severn Estuary Fish Review (Bird, 2008);
- Spawning and Nursery Grounds of Selected Fish Species in UK Waters: Fisheries Sensitivity Maps in British Waters (Coull *et al.*, 1998); updated by Cefas based on more recent survey data and additional analyses to complement the original from 2012, noting that within the Severn Estuary, the additional analyses were an extrapolation and did not survey within this area.

9.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES in relation to fish and shellfish. Individual responses to the comments received in the Scoping Opinions are provided in Appendix A.

The data highlighted within the Scoping Report, was not considered sufficiently adequate to characterise the marine fish assemblage, and its use of the proposed/ current sites. Site specific fish surveys were therefore recommended. In response to these concerns, a more comprehensive review of the information, including up to date available data sources, has been undertaken to describe the baseline environment Section 9.2.

Furthermore, in terms of particularly sensitive fish species, an industry wide approach has been adopted specifically for the assessment of herring and sandeel, which includes an assessment of habitat suitability, and is included in Sections 0 and 9.3.5. The potential impacts on juvenile fish, including cod (codling), which are abundant in the Estuary in the winter months have also been assessed, as advised in the Scoping Opinion from NRW in Section 9.3.

As advised by NRW, the potential effects of dredging on diadromous fish features and sub-features of protected sites have been considered in the HRA (see the 'Appropriate Assessment signposting document' in Appendix C).

9.2 Review of baseline understanding

9.2.1 Regional overview

The fish community of the Severn Estuary is notably species rich and exceeds 100 species in total (Henderson and Bird, 2010). The use of conventional fish sampling techniques in the Severn Estuary is difficult because of the large expanses of inaccessible intertidal areas and the macrotidal conditions (Henderson and Bird, 2010). Most of the available knowledge of the Severn Estuary fish community comes from individuals entrained on the cooling water intake screens used at power stations situated along the English and Welsh shores. Fish and crustacean abundance at Hinkley Point B power station situated at the seaward margin of the estuary in Bridgewater Bay was monitored between 1980 and 2022[9], when Hinkley Point B ceased generating electricity (Henderson and Bird, 2010[10;] Cefas. 2022). Similar records are available from Oldbury power station in the Upper Severn Estuary from 1972 to 1977 and 1996 to 1999 (Henderson and Bird, 2010; Bird, 2008). The location of these power stations is shown in Figure 9-1.

9 Though trend analysis monitoring was only undertaken to 2019 (Cefas, 2022).

10 Given the position of the intake, the surrounding habitat, and also the fact that sampling tends to take place on particular tides every month (intermediate in the spring-neap cycle), it is acknowledged that there will be a bias toward certain species, and that larger species and individuals, as well as benthic species, may be under-represented.

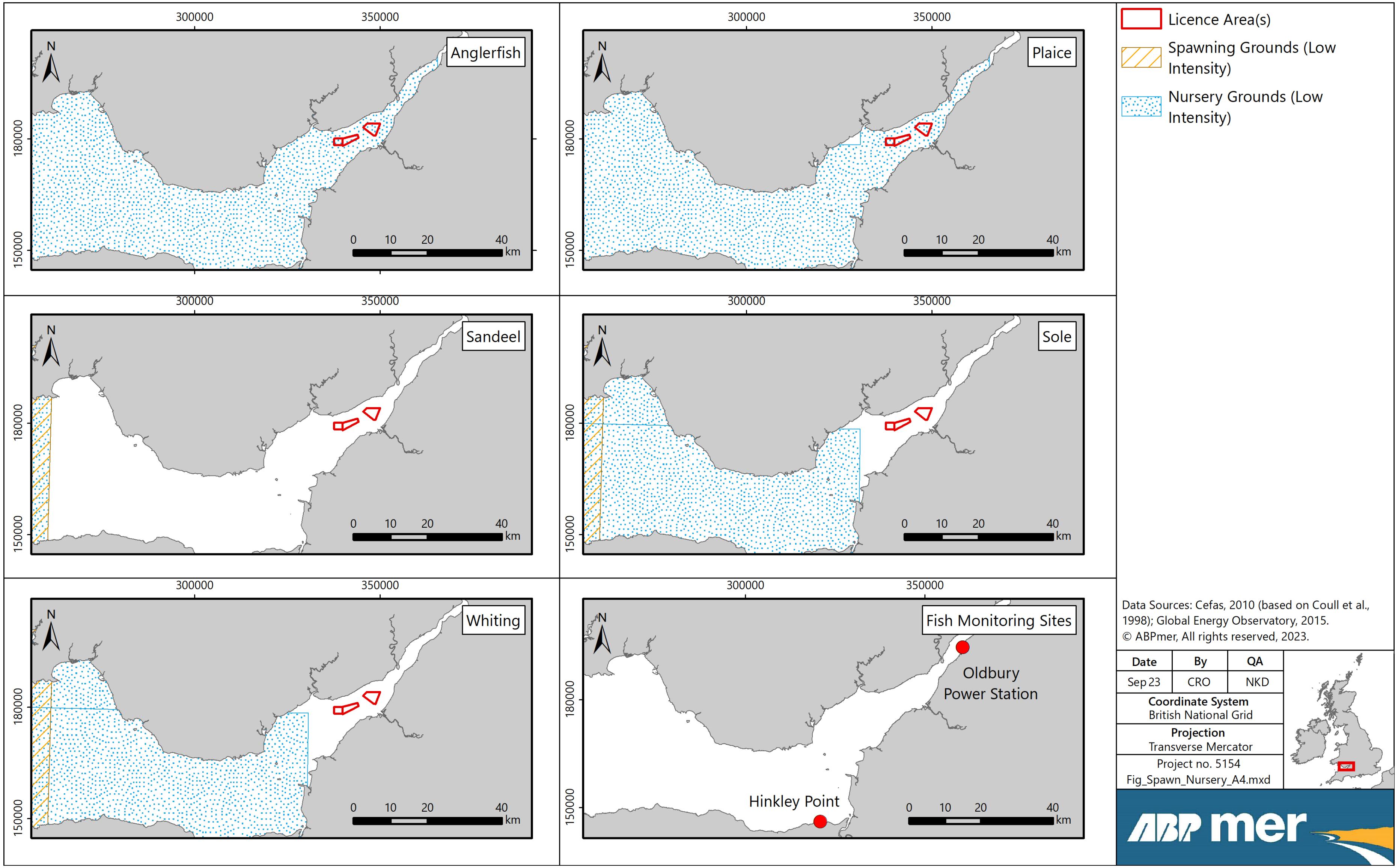

Figure 9-1 **Fish spawning and nursery areas**

The distribution and ecology of demersal fish, pelagic fish, elasmobranchs, diadromous fish and shellfish within the Severn Estuary are each reviewed in more detail below. The review has primarily focused on key species which are of either commercial and / or conservation importance. The functional guilds for estuarine fish defined by Elliott *et al*. (2007) have been used in the tables of this review, in order to provide a summary on the life history and ecology of each fish species:

- Marine stragglers (MS): Species that spawn at sea and typically enter estuaries only in low numbers and occur most frequently in the lower reaches. This category contains fish that are generally intolerant of reduced salinity.
- Marine migrant opportunistic (MMO): Species that spawn at sea and often enter estuaries in large numbers; particularly as juveniles. Some of these species are highly euryhaline and move throughout the full length of the estuary. Species in this category can use, to vary degrees, near-shore marine waters as an alternative habitat.
- Marine migrant dependent (MMD): Species that spawn at sea but often enter estuaries in large numbers, particularly as juveniles that seek the shelter of estuarine habitats. Some of these species are highly euryhaline and move throughout the full length of the estuary.
- Estuarine residents (ER): Estuarine species capable of completing their entire life cycle within the estuarine environment.
- Anadromous (A): Migrate from the sea into fresh water to breed.
- Catadromous (C): Migrate from fresh water into the sea to breed.

Certain fish species are protected under a range of legislation including the EU Habitats Directive, the Wildlife and Countryside Act 1981 (and amendments) and the Bern Convention, as well as being on OSPAR threatened species list, International Union for Conservation of Nature (IUCN) red list and Section 7/NERC lists of principal species. A summary of legislation protecting species relevant to the Severn Estuary can be seen in Table 9-1.

Table 9-1 Summary of UK protection legislation for fish and shellfish species within the Severn Estuary

Group	Category1	Species	Conservation Status and Importance
Diadromous fish species	C	European eel *Anguilla anguilla*	NERC/Environment (Wales) Act, OSPAR listed and on the global red list, Protected under the Eels (England and Wales) Regulations 2009
	A	Salmon *Salmo salar*	NERC/Environment (Wales) Act, Appendix III of Bern Convention; Annexes II, V of the EC Habitats Directive, OSPAR.
	A	Sea lamprey *Petromyzon marinus* and River lamprey *Lampetra fluviatilis*	Annexes II, V of the EC Habitats Directive, NERC/Environment (Wales) Act, Appendix III of Bern Convention (river lamprey), OSPAR (sea lamprey).
	A	Shads *Alosa alosa* and *A. fallax*	NERC/Environment (Wales) Act, Appendix III Bern Convention, Annexes II and V EC Habitats Directive, Wildlife and Countryside Act
	A	Brown/Sea Trout *Salmo trutta*	NERC/Environment (Wales) Act
Pelagic bony fish species	MMO	Atlantic herring *Clupea harengus*	NERC/Environment (Wales) Act (grouped plan); of commercial importance
	MMD	Bass *Dicentrarchus labrax*	Of commercial importance
	MS	Mackerel *Scomber scombrus*	NERC/Environment (Wales) Act (grouped plan); of commercial importance
	MMO	Sprat *Sprattus sprattus*	Of commercial importance
	ER and MMD	Smelt *Osmerus eperlanus*	NERC/Environment (Wales) Act
Elasmobranchs species	MS	Spotted ray *Raja montagui*	OSPAR threatened / declining
	MMO	Thornback skate/ray *Raja clavata*	Environment (Wales) Act; OSPAR threatened / declining; of commercial importance
Demersal bony fish species	MMO	Atlantic cod *Gadus morhua*	Vulnerable (IUCN red list); OSPAR threatened / declining, NERC/Environment (Wales) Act; of commercial importance
	MMD	Dover sole *Solea solea*	NERC/Environment (Wales) Act ; of commercial importance
	MMO	European plaice *Pleuronectes platessa*	NERC/Environment (Wales) Act; of commercial importance
	MS	Sandeel *Ammodytes* species	NERC/Environment (Wales) Act; of commercial importance
	MMO	Whiting *Merlangius merlangus*	NERC/Environment (Wales) Act; of commercial importance

1 Based on Elliott et al. (2007).

Source: JNCC, 2011 http://www.jncc.gov.uk/page-3408

Demersal fish

Demersal species are bottom-dwelling or mid-water fish that have a close association with the seabed. Several commercially important gadoids are frequently recorded in the Severn Estuary, including cod, whiting and pollock. Whiting in particular is considered highly abundant, reaching a peak in the inner Severn Estuary between September and mid-November (Henderson and Bird, 2010; Henderson, 2019). The Severn Estuary is also considered a nursery ground for whiting (Ellis *et al*., 2012), and juvenile cod (codling) are abundant in the Estuary in the winter months (NRW scoping opinion comment). Other demersal roundfish recorded include poor cod, Norway pout, five bearded rockling and sand goby. The Bristol Channel and Severn Estuary is considered to be a low intensity nursery area for whiting and angler fish. No spawning grounds are present in the Severn Estuary for demersal roundish species (Ellis *et al*., 2012).

A range of flatfish species are commonly recorded, including the commercially important sole which is considered abundant in the estuary. Flounder and dab are also regular recoded, with plaice recorded more rarely. The Bristol Channel and Severn Estuary is considered to be a low intensity nursery ground for sole and plaice. No spawning grounds for flatfish species are present in the Severn Estuary (Ellis *et al*., 2012).

Henderson *et al.* (2007) suggested that the fish community in the Severn Estuary and Bristol Channel was rapidly responding to changes in seawater temperature, salinity and the North Atlantic Oscillation (NAO). Monitoring showed that the number of fish caught at Hinkley Point annually followed an increasing trend, which could be related to increased temperature and decreased salinity, with clear long-term trends of increasing species richness and more frequent capture of warmer water demersal species (mullet species, gurnard and trigger fish). Species that are close to the southern limit of their range in the Bristol Channel such as dab and sea snail have declined in abundance though they are still common (Henderson *et al.,* 2007; Bird, 2008; Cefas, 2022).

A summary of the abundance of demersal species in the Severn Estuary is provided in Table 9-2. Spawning and nursery grounds for key commercially important demersal species are shown in Figure 9-1.

Table 9-2 Demersal fish species recorded in the Severn Estuary

Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
Five-bearded rockling	*Ciliata mustela*	MMO	++	+++	The abundance of this rockling had increased since 1997 and, by 2007, was appreciably higher than it was in the 1980s. This positive trend continued to 2019, though it was not statistically significant between 2000-2019.
Cod	*Gadus morhua*	MMO	+	+++	Since 1986, cod had become more abundant within Bridgwater Bay, and from reports from fishermen it would appear cod had generally increased in abundance in the Bristol Channel and the waters surrounding Devon and Cornwall by the late 1990s. However, from 2001 to 2004 abundance declined. This trend was then reversed in 2006 and 2007. A slight decline was noted between 2000-2019, though not statistically significant. Overall, between 1981 and 2019, there was a significant increase in cod impingement at Hinkley Point B.
Whiting	*Merlangius merlangus*	MMO	+++	+++	One of the most abundant fish, Henderson (2019) notes that 'while recruitment shows high between-year variation, the species shows notable long-term stability. Annual whiting abundance within Bridgwater Bay is highly variable, but varies around a stable mean that has not changed over 40 years'
Pollock	*Pollachius pollachius*	MMO	++	++	This species was never abundant but continued to be caught in low numbers.
Poor cod	*Trisopterus minutus*		+++	+++	Commonly recorded; slight declining trend (statistically significant) between 1981 and 2019
Hake	*Merluccius merluccus*	MS	+	+	Once quite common fish, by mid 00s considered an infrequent visitor. The last individual was caught in April 1999.
Norway pout	*Trisopterus esmarkii*	MMO	++	++	Numbers caught were low, with around 5 caught annually to 2006. Slight declining trend (statistically significant) between 1981 and 2019.

Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
Northern rockling	*Ciliate septentrionalis*	MMO	++	+++	This species was once considered rare in Southern British waters. It is notable that while uncommon at Hinkley Point it was regular in its seasonal pattern. Slight increasing trend (statistically significant) between 1981 and 2019.
Greater pipefish	*Syngnathus acus*	MMO	+	++	Rarely recorded.
Nilsson's pipefish	*Syngnathus rostellatus*	MMO	+	+	Rarely recorded.
Snake pipefish	*Entelurus aequoreus*	MMO	+	+++	Slightly increasing trend (statistically not significant) between 1981 and 2019.
Smooth sandeel	*Gymnammodytes semisquamatus*	MS	+	+	No information available*.
Sandeel	*Ammodytes tobianus*	MS	+	+	Only recorded in very low numbers over the years.
Lumpsucker	*Cyclopterus lumpus*	MS	+	++	The species has slightly declined in abundance since the 1980s (statistically significant).
Sea snail	*Liparis liparis*	MMO	+++	+++	The abundance of sea snail is negatively correlated with winter seawater temperature according to Henderson *et al.*, 2007). Thus since 1987 the increase in mean water temperature resulted in generally lower numbers being captured during the 1990s and 2000s as compared with the 1980s. The overall trend was slightly negative from 1981 to 2019 (not statistically significant).
Thin-lipped mullet	*Liza ramada*	MMD	+++	+++	Thin-lipped mullet were caught in modest numbers*.
Dragonet	*Callionymus lyra*	MS	+	++	This species does not live on a mud substrate within estuaries, and is best viewed as an occasional, but regular, visitor. However, 12 were recorded in 2006/7; this was the largest annual catch since records began in 1980. Between 2000 and 2019, a slightly decreasing trend was noted (statistically significant).

Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
Transparent goby	*Aphia minuta*	MS	+	+++	Abundantly recorded, slightly increasing trend over 1981-2019 dataset (not statistically significant).
Sand goby	*Pomatoschistus minutus*	MMD	+++	+++	Abundantly recorded, slightly increasing trend over 1981-2019 dataset (not statistically significant).
Dab	*Limanda limanda*	MMO	+	+++	Over the total period of study this was one of the more abundant flatfish within Bridgwater Bay but showed as overall decline towards the mid-00s. A slight increase, though not statistically significant, was noted between 2000 and 2019.
Flounder	*Pleuronectes flesus*	MMD	+++	+++	There were indications that flounder had become more abundant since 1986, however abundance in 2006/7 was low; this indicated a return to the long-term average abundance. A slight decrease, though not statistically significant, was noted between 2000 and 2019.
Plaice	*Pleuronectes platessa*	MMO	++	++	Within Bridgwater Bay plaice was the least abundant of the common British flatfish. In the summer of 1996/97, a peak of 21 specimens were recorded, followed in 2002 and 2003 by peaks of 15 and 11 respectively. A slight increase, though not statistically significant, was noted between 2000 and 2019.
Sole	*Solea solea*	MMD	++	+++	This species continued to be abundant within the estuary. Most of the sole captured were 'O' group juveniles, mid 00s recruitment was above that observed in the 1980s. A statistically significant substantial increase was noted between 2000 and 2019.

1. Based on Elliott *et al.,* (2007).
2. Relative abundance recorded in the inner Severn Estuary at Oldbury in the 1970s and 1980s (Henderson & Bird, 2010): Rare (+), regular caught (++) and common (+++).
3. Relative abundance recorded in the lower Severn Estuary at Hinkley Point since 2000 (Henderson and Bird, 2010): Rare (+), regular caught (++) and common (+++).
4. Long terms trends from 1980-2007 at Hinkley Point (Henderson *et al.,* 2007); updated with latest trend information from Cefas, 2022.

* Species were not observed frequently enough to have statistics calculated for them by Cefas in 2022.

Pelagic and elasmobranch species

Pelagic species are free-swimming fish that inhabit the mid-water column. They tend to have little association with the seabed and as a result are often distributed over widespread and indistinct grounds, often forming large shoals. Pelagic fish, such as clupeids (herring and sprats) and are important prey resources for seabirds and marine mammals (DECC, 2009).

Herring abundance in the Bristol Channel showed an upward trend in the 2000s (Henderson *et al.,* 2007); impingement trend analysis at Hinkley B to 2019 indicates that this trend continued (Cefas, 2022). Herring spawn in shoals on coarse sand, gravel, shells and small stones in shallow water between 15-40 m depth. Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel, small stones and rock. Young herring spend some time in the inshore areas before migrating offshore to join the adult population. No nursery or spawning grounds for herring are present in the Severn Estuary (Ellis *et al*., 2012; Kay and Dipper, 2009). Sprat is one of the most numerically abundant Severn Estuary fish. The species reaches peak abundance between late July and September in the inner estuary. Sand smelt which are characteristic of many Northern European estuaries, are rarely found in the Severn Estuary because the substrates and turbidity are probably unsuitable for this bottom spawner (Henderson and Bird, 2010). Bass are also recorded seasonally in the highest abundance in September (Bird, 2008). Neither the Estuary nor any of its tributaries are currently designated bass nursery areas, with the closest being at Aberthaw Power Station in the Inner Bristol Channel in South Wales, and in the Taw/Torridge estuary in Devon.

Elasmobranchs are fish which have a cartilaginous skeleton and include sharks and rays. Nursehound and small spotted catshark are two of the most numerous and widespread shark species in UK waters occurring down to depths of 100 m (Kay and Dipper, 2009; DECC, 2009). Both species are recorded in the Severn Estuary with abundances highest in outer parts of the estuary and Bristol Channel.

The thornback ray is the most abundant inshore ray species in the Irish Sea and Bristol Channel and is associated with a variety of substrates including mud, shingle and gravel. The thornback ray is recorded in the outer Severn Estuary, with the nearest nursery ground located in the Bristol Channel (Ellis *et al*., 2012; Bird, 2008).

A summary of the abundance of pelagic and elasmobranch species in Severn Estuary area is provided in Table 9-3. Spawning and nursery grounds for key commercially important species are shown in Figure 9-1.

Table 9-3 Pelagic and elasmobranch fish species recorded in the Severn Estuary

Group	Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
Pelagic species	Herring	*Clupea harengus*	MMO	+++	+++	Herring in 2006/7 recorded the greatest monthly catch, of 94 individuals, since work began in 1980. There are now clear indications that herring abundance in the Bristol Channel is on an upward trend. Over all the monitoring years, Herring accounted for 31 % of the total impinged fish, slightly less than sprat.
	Sprat	*Sprattus sprattus*	MMO	+++	+++	Sprat is the commonest pelagic fish captured at Hinkley Point; generally accounted for 31 % of the total impinged fish.
	Bass	*Dicentrarchus labrax*	MMD	+++	+++	After a very large 2002/3-year class, bass abundance has remained lower 2000-2019 than pre-2000. Recruitment in this species is highly variable and is much higher in exceptionally warm years that occur after a run of cool years. Bass accounted for just over 2 % of the impinged fish at Hinkley Point B over the years.
	Smelt	*Osmerus eperlanus*	ER and MMD	++	+	No information available*.
	Mackerel	*Scomber scombrus*	MS	+	+	No information available*.
Elasmobranch species	Thornback ray	*Raja clavata*	MMO	+	+++	This species became more abundant in Bridgwater Bay in the mid-1980s, when mean water temperatures were lower. Six were captured in 2006/7,. Overall, no significant trend was observed be Cefas.
	Spotted ray	*Raja montagui*	MS	+	+	No information available*.
	Undulate ray	*Raja undulata*	MS	+	+	No information available*.
	Spurdog	*Squalus acanthias*	MS	+	+	No information available*.
	Tope shark	*Galeorhinus galeus*	MS	+	+	No information available*.
	Nursehound	*Scyliorhinus stellaris*	MS	+	+	No information available*.

Group	Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
	Small spotted catshark	*Scyliorhinus canicula*	MS	+	++	Caught occasionally, slight increasing trend from 1980 to 2019 (statistically significant).

. Based on Elliott *et al.,* (2007).
2. Relative abundance recorded in the inner Severn Estuary at Oldbury in the 1970s and 1980s (Henderson and Bird, 2010): Rare (+), regular caught (++) and common (+++).
3. Relative abundance recorded in the lower Severn Estuary at Hinkley Point since 2000 (Henderson and Bird, 2010): Rare (+), regular caught (++) and common (+++).
4. Long terms trends from 1980-2007 at Hinkley Point (Henderson *et al.,* 2007); updated with latest trend information from Cefas, 2022.
* Species were not observed frequently enough to have statistics calculated for them by Cefas in 2022.

Migratory fish

The Severn Estuary is used by a variety of migratory fish species including twaite shad, river lamprey and sea lamprey which are all Annex II qualifying species for the SAC.

The twaite shad is an anadromous species which migrates from marine waters into the lower reaches of estuaries between April and June to spawn in freshwater near the tidal limit (Maitland and Hatton-Ellis, 2003). Three of the four confirmed UK spawning populations of twaite shad are in the rivers Severn, Usk and Wye respectively. Generally, the catches at Hinkley Point Power Station peaked in September and remained relatively high until December; few fish are caught during January and February however a second period of increased abundance was observed in March (Henderson, 2003; Cefas (2022) broadly confirmed this, though reported on in year quarters, with Quarter 4 having the highest percentages, 39%).

The river lamprey and the sea lamprey are both anadromous species, spawning in freshwater but completing part of their lifecycle in estuaries or at sea (Henderson, 2003; Maitland and Hatton-Ellis, 2003). Sea lamprey adult growth phase is short and lasts around two years. In this time the species is parasitic, feeding on a variety of marine and anadromous fishes, including shad, herring, salmon, cod, haddock and basking sharks. The rarity of capture in coastal and estuarine waters suggests that marine lampreys are solitary hunters and widely dispersed at sea. Unlike sea lamprey, the growth phase of river lamprey is primarily restricted to estuaries. Information on the ecology of lamprey species in the Severn Estuary is limited. A single sea lamprey has been recorded in the Hinkley fish surveys up to 2006 from when sampling started, suggesting that Bridgwater Bay is not an important migratory pathway for the species. The River Severn is believed to hold one of Britain's largest spawning populations of river lamprey (Henderson, 2003.)

The Severn Estuary supports an important run of migratory salmon and sea trout. Atlantic salmon are an anadromous species which migrates to freshwater to spawn, whilst spending most of its life in the marine environment. They spawn in upper reaches of rivers, where they live for one to three years before migrating to sea as smolts. At sea, salmon grow rapidly and after one to three years return to their natal river to spawn. The UK and Irish Atlantic salmon population comprises a significant proportion of the total European stock (Malcolm *et al.,* 2010). Atlantic salmon migrate through the Severn Estuary. Data collected on salmon smolts from Oldbury power station demonstrated that their abundance in the estuary peaked in autumn (October) and again in the spring (April and May) although they are present in most other months. It was estimated that the average number of salmon smolts entrained annually on the screens at Oldbury between 1972 and 1977 was 405 individuals (Bird, 2008). The life cycle of the migratory sea trout which is also recorded in the Severn Estuary is similar to that of salmon. However, in contrast to the salmon, the majority of sea-trout survives spawning and will return to their natal spawning river on numerous occasions during their lifetime. Salmon populations have declined historically and NRW (2022) consider that the stocks of salmon on the Severn will likely continue to decline (uncertain trend); no estimate was made for sea trout.

European eel is catadromous species which migrates to the marine environment (Sargasso Sea) to spawn. The Severn Estuary has the largest eel run in Great Britain. The population has dwindled across Europe which is echoed by a dramatic decline in eel numbers seen in the Severn Estuary (Bird, 2008).

A summary of the abundance of migratory species in Severn Estuary area is provided in Table 9-4.

Table 9-4 Migratory fish species recorded in the Severn Estuary

Common Name	Scientific Name	Category[1]	Oldbury Abundance[2]	Hinkley Abundance[3]	Hinkley Long Term Trends (1980-2019)[4]
Atlantic Salmon	*Salmo salar*	A	++	+	Rarely observed
Trout	*Salmo trutta*	A	+	+	No information available*
Allis shad	*Alosa alosa*	A	+	+	No information available*
Twaite shad	*Alosa fallax*	A	+++	++	Henderson *et al.* (2007) noted that the 0-group (<1 year old), which comprise the vast majority of the individuals of this species caught, tended to be more abundant in warmer years. 1981-2019 trend slightly negative, but not statistically significant.
Eel	*Anguilla anguilla*	C	+++	++	Long-term decline in the rate of capture of the species, statistically significant 1981-2019.
River lamprey	*Lampetra fluviatilis*	A	+++	++	Recorded infrequently in surveys.
Sea lamprey	*Petromyzon marinus*	A	+	+	Only a single sea lamprey has been recorded in the surveys to 2007*.

1. Based on Elliott *et al.,* (2007).
2. Relative abundance recorded in the inner Severn Estuary at Oldbury in the 1970s and 1980s (Henderson and Bird, 2010): Rare (+), regular caught (++) and common (+++).
3. Relative abundance recorded in the lower Severn Estuary at Hinkley Point since 2000 (Henderson and Bird, 2010): Rare (+), regular caught (++) and common (+++).
4. Long terms trends from 1980-2007 at Hinkley Point (Henderson *et al.,* 2007), updated with latest trend information from Cefas, 2022.

* Species were not observed frequently enough to have statistics calculated for them by Cefas in 2022.

Shellfish

The section focuses on shellfish species (i.e. molluscs or crustaceans which are consumed by humans). Information on other macrofauna is reviewed in Section 8 (Benthic Habitat and Species).

The most abundant commercially important shellfish species occurring in the Severn Estuary is the common shrimp *Crangon crangon*. There appears to be a single large population of brown shrimp within the Bristol Channel and Severn Estuary. This shellfish species is not currently commercially fished (Section 12.2) and is likely to be present in low densities (less than one per 10 m^2) (HR Wallingford, 2003; Emu, 2001). This crustacean reproduces first when about one year old with peaks in reproductive activity in January and late spring. The population size in the Severn Estuary varies seasonally, with maximum abundance occurring in early autumn at the completion of annual recruitment. Monitoring of fish and crustacean species captured on the intake screens of Hinkley Point has found the number of recruits to show a high degree of inter annual variation and has been found to be positively correlated with both average water temperature from January to August and river flow rate, and negatively correlated with the Winter NAO Index (Henderson *et al.,* 2006; Henderson *et al.*, 2007).

Oysters are also commercially farmed at Porlock Bay over 50 km from the proposed aggregate dredge areas. Other shellfish species recorded in the Severn estuary include the edible prawn *Palaemon serratus*, whelk species, winkle species and the blue mussel (Walmsley and Pawson, 2007).

9.2.2 Site specific baseline

Cefas North Middle Ground surveys (October 1999 and October 2000)

Cefas undertook fish surveys of the NMG in October 1999 and October 2000. The abundance of fish recorded in the trawl surveys is presented below and summarised in Table 9-5.

Table 9-5 Fish recorded in the October 1999 and October 2000 trawl surveys

Species	October 1999 Survey	October 2000 Survey
Sole	1	6
Dab	5	11
Whiting	1	3
Cod	0	2
Poor cod	0	1
Plaice	0	3
Brill	0	2
Bib	1	0
Sprat	4	0
Sandeel	5	0
Common goby	0	1
Sand goby	35	20
Total number of species	**7**	**9**
Total number of individuals	**53**	**49**

Results of the October 1999 survey

Eight seine net hauls (which targets fish in the inter-tidal and shallow sublittoral) were undertaken as part of the 1999 monitoring survey, three on the ebb tide and five on the flood tide. The ebb hauls caught one first year red mullet and a number of brown shrimp. The flood tide hauls produced five first-year bass and a few brown shrimp (HR Wallingford, 2003).

A 1.5 m Aggasiz trawl (which targets demersal species) was also used to survey fish as part of the monitoring. The trawl was towed at 2.5 - 3.0 knots and covered approximately 1200 m² of ground per 10-minute tow. Sand gobies were the most abundant fish species (densities of 1.7/1000 m²). The only flatfish encountered were a total of five dabs (all 0-group i.e. <1 year old)) and one 0/1 (<2-year-old) group sole. Densities were extremely low at around 0.05/1000 m² and 0.2/1000 m² for sole and dabs respectively. The other fish species caught were whiting, bib, cod, poor cod, sprat, greater sandeel, common goby and pogge, all in low numbers and mainly 0/1 group specimens (HR Wallingford, 2003).

In order to use these results to indicate the significance of the NMG as a nursery ground for commercial fish, it is possible to compare the densities observed with those for the same species in known nurseries around the British coast. Inshore young fish surveys have been carried out around the coast of the southern North Sea and English Channel by Cefas annually in September/October since 1981, using a combination of 2 m beam trawls and push-netting. These sampling gears are likely to have a sampling efficiency similar to that of the Agassiz trawl. The annual mean densities of first year (0-group) soles were between 2.0 and 2.5 fish per 1000 m² in the southern North Sea and English Channel young fish surveys. Approximately 50% of the North Sea and English Channel samples had a density of at least 2.5/1000 m² which would be considered indicative of a nursery area. Sole was recorded in much lower densities and at levels which would not be considered indicative of a nursery in the 1999 NMG survey (HR Wallingford, 2003).

The annual mean density of dabs (of all ages) recorded in the young fish surveys was 3.5 fish per 1000 m². Approximately 28% of the samples fell below 1/1000 m² and around 50% of the samples had a density of at least 3.5/1000 m². Dab catch rates on NMG (0.2/1000 m²) are within the lower 10% range of all samples taken elsewhere (HR Wallingford, 2003).

This analysis suggests that NMG is of little significance as a fish nursery ground for either sole or dab, which were the main fish species caught in the trawls. Although 0-group bass were caught by beach seine along the edge of NMG, it is most likely that these fish were moving inshore with the tide and that they would not be found there once the water was above the sand banks (HR Wallingford, 2003).

There were currently no commercially important shellfish species recorded in the survey.

Results of the October 2000 survey

The survey used a 1.5 m Aggasiz trawl with a 5 mm mesh cod-end liner as used in the October 1999 survey. The trawl was towed at 2.5 - 3.0 knots (covering approximately 1200 m² of ground per 10-minute tow).

Overall, sand gobies were the most abundant fish species in the October 2000 survey, caught at an average of 0.79/tow which represent densities of less than 1 per 1000 m². This is less than a third of the density recorded in 1999 (HR Wallingford, 2003).

Larger numbers of flatfish were caught in 2000 compared with 1999 although they were still few in number. In total 11 dabs (all 0-group), six sole (5 0-groups and one older fish), three plaice and two brill were recorded. Densities of sole were around 0.4 per 1000 m². However, there were fewer roundfish species caught than in 1999 (three whiting, two cod, one poor cod, 20 sand gobies (see above), one common goby. These species were all mainly 0/1 group specimens (HR Wallingford, 2003).

The trawl survey undertaken in 2000 was a carried out at the same time of year and under similar tidal and climatic conditions to that in 1999. Densities of all species encountered were again very low, and some species (bib, sprat and sandeels) that were present in 1999 were absent in 2000. Brill were recorded for the first time in 2000. Although catch numbers of the two main flatfish species, sole and dabs were higher in 2000 than in 1999, numbers were still low (HR Wallingford, 2003).

The survey report concluded that ‘the 2000 survey confirm the findings of the 1999 survey, that the NMG has an impoverished benthic fauna, with few if any fish of commercial interest, and no evidence of being a flatfish nursery area of any significance’ (HR Wallingford, 2003).

As also observed in the 1999 survey, there were currently no commercially important shellfish species recorded in the survey.

NRW and Environment Agency fish monitoring at Bedwyn Sands

NRW and the Environment Agency undertake fish surveys at multiple locations throughout the Severn Estuary as part of WFD TraC monitoring. Fish surveys are undertaken at Bedwyn Sands using demersal otter trawl surveys to primarily target bottom-dwelling fish. Bedwyn Sands is a continuation of the sandflat at NMG with similar current strength and substrate type. The fish communities associated with these areas two areas are therefore assumed to comprise the same species in similar levels of abundance (HR Wallingford, 2003).

Data was available from the Environment Agency for 2003 and between 2007 and 2015 (Environment Agency, 2021). The results of these surveys are presented in Table 9-6. Low numbers of fish species have generally been caught in the trawl surveys at Bedwyn Sands. The most abundant demersal roundfish species recorded were sand goby and whiting (with an average abundance of 21 and 15 individuals respectively). Common goby were also recorded relatively frequently (average of 11 individuals). All other demersal roundfish species had average abundances of two or less fish per trawl survey.

Dover sole, plaice and flounder were the most abundant flatfish species, with an average abundance of two fish per trawl. Herring, sprat and smelt have been recorded periodically in low numbers, consisting of a few individuals (which would be expected given the fishing gear used). No other pelagic species have been recorded in the surveys. In addition, no migratory species have been recorded throughout the monitoring period.

Table 9-6 Fish recorded in EA fish monitoring at Bedwyn Sands

Row Labels	2003	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Average
15-spined stickleback	0							1			1	<1
3-spined stickleback	0		1								1	<1
Brill	0	6		2		2			1		11	1
Cod	0			5	2		1	2		10	20	2
Common goby	0		100				5	4			109	11
Dover sole	0	2	18	2	1						23	2
Flounder	2			10		1	1			2	16	2
Greater pipefish	0				1		1				2	<1
Gudgeon										9	9	1
Herring	0				2						2	<1
Hooknose/ Pogge	0				1						1	<1
Lesser sandeel	0							1			1	<1
Plaice	0	1	9		7		2	1			20	2
Poor cod	0							1			1	<1
Pouting/Bib	1		6			1					8	1
Sand Goby	3	87		5	39	20	1	1	5	53	214	21
Sand smelt	0			1					1		2	<1
Sea-snail	0	1									1	<1
Sprat	0	2	1			3	6				12	1
Thornback ray	0	1			1						2	<1
Transparent goby	1										1	<1
Tub gunard	0				1						1	<1
Whiting	5	11	70	3	33		8	12	0	10	152	15
Total number of species	**5**	**8**	**7**	**7**	**10**	**5**	**8**	**8**	**3**	**5**	**66**	**7**
Total number of individuals	**12**	**111**	**205**	**28**	**88**	**27**	**25**	**23**	**7**	**84**	**610**	**61**

9.3 Impact assessment

Dredging in Bedwyn Sands and NMG has the potential to affect fish and shellfish populations through the following pathways (and potential impacts):

- **Draghead**: Extraction activities have the potential to cause a change in the distribution of fish and shellfish by disturbance to habitats or through noise and vibration or direct damage through the uptake of individuals or removal of suitable habitat;
- **Overspill**: The suspended sediment will result in localised increases in turbidity and subsequent sedimentation which could potentially affect the quality of habitat and/or result in a change in the distribution of fish and shellfish;
- **Screening**: This will result in the same, albeit more localised, effects as the overspill (see above); and
- **Vessel presence**: The presence of the dredger may cause an increase in noise and vibration. Lighting could also cause impacts due to dredging taking place on a 24-hour basis.

Impact pathways not included in the assessment: All identified impact pathways have been considered in the assessment and no pathways have been scoped out.

Impact pathways included in the assessment: The key impact pathways relating to fish and shellfish ecology addressed in the following sections are:

- Potential impacts of seabed removal on spawning, nursery and feeding grounds (direct and indirect effects) (Section 9.3.1);
- Potential impacts on fish and shellfish due to changes in water quality (due to fine sediment plume and fine sand dispersion) (direct and indirect effects) (Section 9.3.2);
- Potential impacts to fish and shellfish due to noise, vibration and lighting (Section 9.3.3);
- Sandeel assessment (Section 9.3.4); and
- Herring assessment (Section 9.3.5).

The assessment envelope for this impact assessment can be found in Section 3.4 (dredging programme).

To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied to determine the significance of effects (Section 4.4).

Throughout the impact assessment, the importance of fish is considered to range from high for species of conservation interest (including all migratory species cited as qualifying features of the internationally designated sites, and those species listed as being of national importance, including priority species of principal importance in England and Wales under Section 7 of the Environment (Wales) Act and Section 41 of the NERC Act, or which are considered commercially important (such as cod, herring) to moderate for commonly occurring estuarine species such as gobies. The scientific review primarily focuses on fish species and, where applicable, also includes information on shellfish species.

Following advice received in the Scoping Opinions, an industry wide approach has been adopted specifically for the assessment of herring and sandeel, and these species are therefore assessed in a separate subsection after fish and shellfish.

When reading the baseline summaries and references to trawl data, the limitations with regard to scientific surveys capturing certain fish species and most commercial shellfish species, or life stages thereof, which were set out in Section 9.2.2, should be borne in mind. For herring and sandeel specifically, reference should also be made to MarineSpace (2018).

9.3.1 Potential impacts of seabed removal on spawning, nursery and feeding grounds (direct and indirect effects)

General scientific context

Indirect effects (food chain)

Seabed removal has the potential to directly impact demersal fish but, more importantly, could also impact upon the benthic communities that are prey for fish and shellfish, and consequently could alter the distribution and presence of target species in the region. A Marine Aggregate Levy Sustainability Fund (MALSF) study found that the majority of fish species studied, including cod, were benthic invertebrate feeders with a strong preference for crustacea (Pearce, 2008). A small group of fish species comprising plaice, dover sole, lemon sole and dab, were classified as benthic invertebrate feeders with a strong preference for polychaetes. Another small group comprising sandeel and whiting were classified as benthic invertebrate and piscivorous feeders. Overall, the study found that the majority of fish species studied showed some trophic adaptability in their diet. The mobile nature of the majority of fish species and the widespread availability of prey throughout the region, together with the fact that most species are opportunistic and generalist feeders, means that most are not reliant on a single prey item. Therefore, a change in dietary composition as a result of aggregate dredging may not be damaging to the fish population as the majority of species are likely to switch to alternate prey sources in the event of an impact on their preferred prey, providing sufficient biomass is available to support them (Pearce, 2008).

Indirect effects (habitat change)

Should the removal of seabed lead to habitat loss, it could potentially impact on critical habitats including spawning, nursery and feeding grounds that have an important ecological function. Fish species that spawn directly onto the seabed are more sensitive to the effects of seabed removal than those that spawn into the water column. Herring and black bream use coarse sediments as spawning grounds. These species along with sandeel species which live within the sediment are considered particularly sensitive to habitat change (Tillin *et al.*, 2011). Impacts on sandeel and herring are assessed separately in Sections 9.3.4 and 9.3.5.

The loss or alteration of habitat may also affect shellfish species. Shellfish species generally show a preference for a particular habitat e.g. coarser, gravelly sediments appear to be preferred by brooding female brown crabs in which they partially bury and over-winter in a dormant state (Eaton *et al.*, 2003). Research shows that under the path of the draghead there tends to be a 30-70 % reduction in species diversity, a 40-95 % reduction in the number of individuals and a similar reduction in biomass of benthic communities (Newell *et al.*, 1998). Recovery of many benthic invertebrate populations, including shellfish species will depend on new juvenile recruits settling at the location in the form of larvae rather than the migration of adults. Further details on the recovery of benthic species and habitats can be seen in Section 8 (Benthic Habitats and Species).

Direct effects (uptake)

Hydraulic entrainment, through the direct uptake of aquatic organisms by the suction field generated at the draghead or cutterhead during dredging operations has the potential to result in the by-catch of fish eggs, larvae and even mobile juveniles and adults (Wenger *et al.*, 2017).

Limited research has been carried out regarding entrainment rates of fish in marine dredging. Lees *et al.* (1992) sampled the outwash from an aggregate dredger in the English Channel and recorded the species. In five x 10 minute samples, 22 fish were sampled and a further red gurnard was found from the surface of the hopper cargo. Most fish appeared physically undamaged and would have been washed back to sea, however the scope of the study did not include assessments of their subsequent survival rates. Demersal fish with poorer hearing sensitivity including flatfish and elasmobranchs are considered more likely to be entrained by the dredger drag head (Reine and Clarke, 1998; Stelzenmuller *et al.* 2010). Large and active demersal and pelagic juvenile and adult finfish are likely to avoid dredging areas during operations in response to noise levels and increased turbidity (Tillin *et al.*, 2011).

In general, eggs, embryo and larval stages are considered more vulnerable to entrainment than adults. While the entrainment rates are likely to represent a small proportion of total larval production, fish entrained at the egg, embryo and larval stages will experience extremely high mortality rates although mortality rates will vary among fish species and development stages (Wenger *et al.*, 2017).

Few infaunal benthic invertebrates (including shellfish species) are able to escape entrainment (Newell *et al.*, 1998). Some individuals may survive entrainment and be returned to the sea in the outwash or during screening although heavily shelled shellfish species such as bivalves, snails and crabs are more likely to be retained within the hopper and therefore would be lost with the cargo (Tillin *et al.,* 2011).

Impact assessment (excluding sandeel and herring)

Indirect effects (food chain)

The benthic resources of Bedwyn Sands and NMG are considered to be typically low in biomass and species diversity and impacts from dredging in the study area on benthic species and habitats were considered to be minor adverse at worst (see Section 8). These areas are therefore likely to provide a limited prey resource for demersal and flatfish species. Generally, only low abundances of fish species have been recorded as part of the surveys undertaken on, or near, Bedwyn Sands and NMG (see Section 9.2.2). The mobile nature of the majority of fish species, together with the fact that most species are opportunistic and generalist feeders, means that most are not reliant on a single prey item or a localised area.

Based on these factors, magnitude is considered to be small and probability low. Consequently, the exposure of all fish and shellfish to food chain changes is considered to be negligible and thus impacts are considered **insignificant.**

Indirect effects (habitat change)

Should the removal of seabed lead to habitat loss, it could potentially impact on critical habitats including spawning and nursery and grounds that have an important ecological function. Fish species that spawn directly onto the seabed would be more sensitive to the effects of seabed removal than those that spawn into the water column.

Whiting, anglerfish, plaice and sole are the only commercially important species which are considered to have low intensity nursery grounds in the Severn Estuary (Ellis *et al.*, 2012). No high intensity nursery grounds or spawning grounds are considered to occur in the Severn Estuary. However, it should be noted that the survey data used to produce the Ellis *et al.* (2012) report does not extend as far upstream as the Severn Estuary.

Low abundances of fish species and brown shrimp have been recorded as part of the fish monitoring at Bedwyn Sands and NMG (HR Wallingford, 2003; NRW, 2015). Furthermore, the lack of young fish recorded in surveys on NMG and in the wider are near Bedwyn sands suggests the study area is unlikely to be an important nursery ground for any fish species (HR Wallingford, 2003).

Magnitude of change on the general fish assemblage, excluding sandeel and herring, is considered to be negligible. This is due to the low likelihood of significant spawning or nursery grounds being present, the low abundance of species recorded in surveys and that only very small areas would be affected at any one time. More importantly, however, no significant habitat change should take place as the marine aggregates industry is committed to observing mitigation measures which ensure that the seabed sediments remain similar following dredging activities (see Section 3.5). Consequently, the exposure of fish and shellfish to habitat change would be negligible and, thus, impacts are considered **insignificant**. This assumes that those industry best practice measures already in place for other nearby Licence Areas will continue to be adhered to.

Direct effects (uptake)

Finfish

During aggregate dredging, there is the potential for fish and fish eggs to be directly taken up by the action of the draghead. However, there is considered to be a low likelihood of significant spawning or nursery grounds being present with only very low abundances of fish recorded in the study area. Fish at greatest risk are demersal species with poorer hearing sensitivity, including flatfish and elasmobranchs (Tillin *et al.*, 2011). Although there is a temporary risk of entrainment of fish during dredging, most fish are considered to have the mobility to avoid sources of disturbance and are likely to exhibit a behavioural avoidance reaction to the noise generated by the dredger, therefore, greatly limiting their direct uptake.

Fish eggs could also be taken up with the dredged material and may be damaged, destroyed or re-dispersed during the overspill and screening process. However, any fish or fish eggs that may occur in Bedwyn Sands and NMG are thought to be widespread elsewhere in the surrounding study area. Due to their higher sensitivity to dredging, impacts on sandeel and herring are assessed separately below.

Overall, although there is a risk of direct uptake of fish and fish eggs during dredging, the exposure is considered to be negligible. Consequently, the impact of seabed removal on fish and eggs is considered to be **insignificant.**

Shellfish

General (excluding brooding Crustacea): Several important species of shellfish are present in the waters in the wider study area. Shellfish species generally show a preference for a particular habitat (Edwards, 1979; Howard, 1982; Eaton *et al.*, 2003). The section focuses on the shellfish species which are non-brooding which in the region is considered to consist of oysters, whelks, winkles and mussels.

Non-brooding species of shellfish are fairly widely distributed in the wider study area. Furthermore, it should again be noted that, no significant habitat change should take place as the marine aggregates industry is committed to observing mitigation measures which ensure that the seabed sediments remain similar following dredging activities, and certain thickness of sediment is retained (see Section 3.5).

Given these mitigation measures and given that these species are widely distributed across the wider study area and have not been recorded within or near to Bedwyn Sands and NMG, the exposure change is considered negligible. Consequently, the impact of seabed removal on non-brooding species of shellfish is, therefore, considered to be **insignificant**.

Brooding Crustacea: Unlike fish, crustacea brood their eggs. Lobsters, shrimps and crab species present in the Severn Estuary retain a relatively high mobility during incubation and are likely to be able to avoid direct uptake by the dredger.

There is considered to be a low likelihood of brooding crustacea being present within Bedwyn Sands and NMG. Given established mitigation measures (see Section 3.5), the exposure to change is assessed as negligible. Consequently, the impact of seabed removal on brooding species of shellfish is, therefore, considered to be **insignificant**.

9.3.2 Potential impacts to fish and shellfish due to changes in water quality (due to fine sediment plume and fine sand dispersion) (direct and indirect effects)

General scientific context

There is the potential for impacts on fish and shellfish associated with changes in water quality during aggregate dredging. Dredging may increase suspended sediment concentration (SSC) and release toxic contaminants bound in sediments. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen levels. These changes, in turn, have the potential to affect the distribution and health of fish and shellfish species (Britwell, 2000).

Elevated suspended sediment concentrations

Increased suspended sediments can lead to physiological effects in adult finfish resulting from the abrasion of sediment particles on gill tissues, causing reduced gill function and possible mortality (Wenger *et al.*, 2017; Kjelland *et al.,* 2015). Such effects on fish are considered to occur at suspended sediment levels of around 10,000 mg/l (Britwell, 2000). High SSC levels may impact spawning and nursery grounds through damage to eggs and planktonic larvae, as well as causing abrasion or clogging of the fragile gills of larval and juvenile fish, resulting in mortality or reduced growth rates.

Because turbidity often impairs visual acuity, activities and processes that require vision can be inhibited, leading to behavioural responses. For example, foraging in both planktivorous and piscivorous fish can be negatively affected by suspended sediments. Piscivores are especially sensitive to increasing turbidity because many are visual hunters that detect prey from a distance. An increase in suspended sediment reduces both light and contrast, decreasing encounter distances between predator and prey (Wenger *et al.*, 2017).

Elevated suspended sediments can also influence the movements and migrations of fish. For example, a range of salmonid species have been observed actively avoiding moving through areas with suspended sediment plumes (Wenger *et al.*, 2017; Kjelland *et al.,* 2015). However, such responses can cease if fish become acclimatised. Fish in high latitude coastal areas typically have to contend with variable turbidity and often poor visual conditions, resulting from fluctuations in ambient light levels, suspended sediments and in the light transmission properties of the water. For example, concentrations as high as 9,000 mg/l have been recorded in the path of salmon runs in the Usk Estuary (Alabaster, 1993). Similarly, lamprey and shad species have been known to successfully pass through estuaries with extremely high suspended sediments and, therefore, can be considered tolerant of turbid conditions (Scottish Government, 2010). The mobile nature of fish species generally allows avoidance of areas of adverse conditions which are unlikely to significantly affect a population provided such conditions are temporary.

Crustacean shellfish, including brown crabs, and lobsters, are considered to have a low sensitivity to changes in SSC and smothering (Last *et al.*, 2011; Pearce, 2008). Most bivalves and crustacea are also able to move away from the area of impact after being heavily buried. Many filter feeding bivalves are adapted to large natural variations and mussels, for example, can protect themselves from very high levels of SSC by closing their valves. Experimental work undertaken by Last *et al.* (2011) indicated that typical SSCs associated with marine aggregate dredging may have consequences for the fitness of bivalves, specifically the common mussel and queen scallop, as a result of the increased energetic costs involved in altering their behaviour (e.g. closing shells, clapping and coughing). These changes, however, were not considered to be of a scale that would impact their overall survival.

Lobsters, shrimps and many crab species retain a relatively high mobility during incubation of their eggs and are likely to be able to move away from dredging plumes, edible crabs have a very large egg mass and remain largely sedentary and buried in the sediment during the incubation period. During this period of relative immobility, edible crabs (both adults and eggs) are more vulnerable to smothering (MES, 2007).

Organic enrichment and oxygen depletion

The resuspension of sediments containing organic material can cause oxygen depletion within the water column. The subsequent settling of this organic rich sediment can deplete the sediments of oxygen and affect shellfish and benthic prey items used by fish. The response of fish to low concentrations of dissolved oxygen is determined by a range of factors, including the duration of exposure, water temperature and the presence of other pollutants (Wenger *et al*., 2017). The duration of any low dissolved oxygen event is a key factor in determining its effect. Most fish would survive an extremely low concentration of dissolved oxygen, such as 2 mg/l, for a few minutes, but a longer exposure would start to have sub-lethal and eventually lethal effects (ABP Research, 2000).

Release of contaminants

The potential release of contaminants during construction and dredging activities may result in those contaminants becoming available for uptake by any fish and/or shellfish in the water column or on surface sediments. There is an indirect risk to some finfish species as sediment-bound contaminants may temporarily bioaccumulate in the tissues of certain fish prey, such as polychaete worms and marine bivalves, and made available for uptake by feeding fish.

The influence of contaminated sediments is considered to have a greater impact on fish than elevated SSC with a range of evidence suggesting that direct exposure to contaminants negatively affects fish (Wenger *et al*., 2017). Hydrophobic contaminants (such as legacy persistent organic pollutants including Polychlorinated Biphenols (PCBs) and organochlorine pesticides) as well as high-molecular weight polyaromatic and aliphatic hydrocarbons (such as Polycyclic Aromatic Hydrocarbons (PAHs)), are closely associated with organic material in sediments. These contaminants have been linked to a range of potential reproductive impacts on adult fish (e.g. steroidogenesis, vitellogenesis, gamete production or spawning success) as well as lethal and non-lethal developmental (spinal and organ development, growth) impacts on embryos and larvae (Johnson *et al.,* 2014).

Demersal fish species, such as dab and flounder, which remain close to the seabed and feed mainly on benthic organisms, would experience a higher exposure to contaminated sediments than pelagic fish such as herring (DECC, 2016).

Impact assessment

Elevated suspended sediment concentrations

Finfish and general shellfish assemblage (excluding brooding crustacea): The changes in water quality and the temporary deposition of disturbed sediment during overspilling and screening activities could potentially impact on available fish and shellfish. The predicted increases in SSC will only occur during dredging operations and for several hours after the cessation of dredging. Even when these temporary concentration increases occur, they will be of a similar magnitude to those which occur naturally as a result of variation in tidal conditions and waves, particularly given the naturally high background turbidity levels experienced in the Severn Estuary (see Section 6.3). Furthermore, the worst-case footprints of the plume are localised.

Therefore, while the probability of a localised effect is high, magnitude and consequently exposure to change is assessed as negligible. As noted in the preceding section, fish and shellfish within the region are well adapted to living in an area with variable sediment loads. Most shellfish species such as whelks are generally considered to have a low sensitivity to changes in suspended sediments and smothering and are adapted to living in an environment with variable and relatively high suspended sediment loads. Furthermore, the high mobility of finfish enables them to move freely to avoid areas of adverse conditions and to use other food sources in the area. Sensitivity of fish and shellfish is therefore assessed as low and consequently vulnerability is also assessed as none. Therefore, the impact is considered to be **insignificant**.

Brooding crustacea: Crustacea brood their eggs. Lobsters, shrimps and crab species present in the Severn Estuary retain a relatively high mobility during incubation and are likely to be able to move away from dredging plumes.

There is considered to be a low likelihood of brooding crustacea being present within Bedwyn Sands and NMG. Given established mitigation measures (see Section 3.5), the exposure to change is assessed as negligible. Consequently, the impact of elevated SSC on brooding species of shellfish is, therefore, considered to be **insignificant**.

Organic enrichment and oxygen depletion

Bedwyn Sands and NMG are primarily composed of sand as opposed to organic-rich material (see Section 6.3.2). Waters in the Severn Estuary are well mixed as a result of the hyper-tidal regime within the estuary and waters are typically well oxygenated (i.e. not sensitive to change). The brief increases in SSC were assessed as causing an insignificant change to dissolved oxygen (Section 6.3.2). The probability of a localised effect is therefore low, and the magnitude of change is considered to be negligible, leading to a negligible exposure to change. Therefore, while the sensitivity of fish and shellfish to organic enrichment and dissolved oxygen is low to moderate, the impact is considered to be **insignificant.**

Release of contaminants

Sediment contamination levels in Bedwyn Sands and NMG are expected to be negligible (Section 6). In addition, the increases in SSC during dredging activities will be brief and localised and will not cause elevated levels of water column contamination. Therefore, the magnitude of change is considered to be negligible, leading to a negligible exposure to change. The impact is therefore considered to be **insignificant.**

9.3.3 Potential impacts to fish and shellfish due to noise, vibration and lighting

General scientific context

Elevated noise and vibration levels caused by the action of the dredger could potentially disturb fish and shellfish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.*, 2015). The ability to detect and localise the source of a sound is of considerable biological importance to many fish species and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions. Crustacea are also thought to utilise sound in a similar way (Section 8.3.5).

Dredging produces broadband and continuous sound[11], mainly at lower frequencies of less than 500 Hz and moderate root mean squared (RMS) source levels (SLs) of around 150 to 188 dB re 1 µPa m (Thomsen *et al.*, 2009; Robinson *et al.*, 2011; WODA, 2013; MMO, 2015; Jones and Marten, 2016). Marine aggregate extraction off the UK is predominantly undertaken by Trailing Suction Hopper Dredger

[11] Continuous sound is defined here as a sound wave with a continuous waveform, as opposed to transient/pulsed sounds such as pile driving that start and end in a relatively short amount of time.

(TSHD), although static dredging is sometimes practiced. For most dredging activities, the main source of noise relates to the vessel engine noise, with additional higher frequency sound generated by sand and gravel rising up through the suction pipe, the movement of the draghead on the seabed and splashing from the spillways. SLs of TSHDs are variable but generally range from 160 to above 180 dB re 1 µPa m for large TSHDs (Robinson *et al.*, 2011). The most intense sound emissions from the TSHDs are in the low frequencies, up to and including 1,000 Hz in most cases (Robinson *et al.*, 2011; De Jong *et al.*, 2010). Differences in SLs are mainly a result of the difference in size between the dredging vessels observed rather than the materials dredged. Overall, a worst-case unweighted RMS SL of up to 188 dB re 1 µPa m is assumed for aggregate dredging.

The key finding of a 2011 MALSF study was that the noise output of dredging vessels is similar to a 'noisy merchant vessel' at frequencies less than 500 Hz and is substantially quieter in terms of acoustic energy output than some other anthropogenic noise sources, such as seismic airguns and marine pile driving (Robinson *et al.*, 2011). Dredgers generate higher levels of noise at frequencies above 1 kHz than a typical merchant vessel. Analysis of the measured data for differing operational modes leads to the conclusion that the major source of this higher frequency noise is the impact/abrasion of the aggregate material passing through the draghead, suction pipe and pump (possibly with some additional contribution due to cavitation noise).

From the few studies of hearing capabilities in fishes that have been conducted, it is evident that there are potentially substantial differences in auditory capabilities from one fish species to another (Hawkins and Popper, 2016). Popper *et al.* (2014) proposed the following three categories of fish which are described below:

- Fishes with a swim bladder or air cavities which aid hearing;
- Fishes with a swim bladder which does not aid hearing; and
- Fishes without a swim bladder.

The first category comprises fish that have special structures mechanically linking the swim bladder to the ear. These fish are sensitive primarily to sound pressure, although they also detect particle motion (Hawkins and Popper, 2016). They have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in the other categories. Allis and twaite shad are considered to have a swim bladder which aids hearing (Based on premise that other fish in the herring (clupeid) family, including herring and sprat, are classed as such; see Popper *et al.*, 2014).

The second category comprises fish with a swim bladder where the organ does not appear to play a role in hearing. Some of the fish in this category are considered to be more sensitive to particle motion than sound pressure and show sensitivity to only a narrow band of frequencies, namely the salmonids (Salmonidae) (Hawkins and Popper, 2016). This second category also comprises fishes with swim bladders that are close, but not intimately connected, to the ear, such as cod fishes (Gadidae) and eels (*Anguillidae*). These fishes are sensitive to both particle motion and sound pressure, and show a more extended frequency range, extending up to about 500 Hz (Popper and Coombs, 1982; Jerkø *et al.*, 1989; Popper and Fay, 2011; Hawkins and Popper, 2016).

The third category comprises fishes lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to only a narrow band of frequencies (e.g. flatfishes and sharks skates and rays). River and sea lamprey for example do not have a swim bladder.

Particle motion rather than sound pressure is considered to be potentially more important to fish without swim bladders and salmonids. Acoustic particle motion in the water and seabed, for example, has been shown to induce behavioural reactions in sole (Mueller-Blenkle *et al.*, 2010). However, there is no published literature on the levels of particle motion generated during construction activities (e.g.

pile-driving and dredging) and the distance at which they can be detected. This may be due to the fact that there are far fewer devices (and less skill in their use) for detection and analysis of particle motion compared to hydrophone devices for detection of sound pressure (Martin *et al.*, 2016). Direct measurements of particle motion have also been hampered by the lack of guidance on data analysis methods.

Particle velocity can be calculated indirectly from sound pressure measurements using rather simple models (MacGillivray *et al.*, 2004). However, such estimates of sound particle velocity are only valid in environments that are distant from reflecting boundaries and other acoustic discontinuities. These conditions are rarely met in the shelf-sea and shallow-water habitats that most aquatic organisms inhabit and that are applicable to the study area (Nedelec *et al.*, 2016).

It is currently unknown how coupling of vibrations to the substrate will affect bottom dwelling flatfish and little is known about the hearing capabilities of invertebrates, so potential effects are very difficult to assess (Section 8.3.5). Some crustacea are able to detect and use sound in ways that are similar to detection and processing of acoustic stimuli in aquatic and terrestrial vertebrates. Studies have indicated that crustacean species are able to respond to a wide frequency bandwidth, although their sensitivity to underwater sound and vibration is very much lower than fish. Parvin *et al.* (2008) measured the vibration of a TSHD on the seafloor. The predicted vibration levels close to the source (root-mean-square (rms) levels of 0.1 mm/s) were many orders of magnitude smaller than those used in laboratory-based studies to explore resonant behaviour in crab limbs (rms levels of 300 mm/s). It was concluded that these vibration levels were unlikely to cause disturbance to species of crab (Parvin *et al.*, 2008).

There is also very limited information available on the hearing abilities of elasmobranch fishes (sharks, rays and skates). The hearing abilities among sharks have demonstrated a high sensitivity to low frequency sound (40 Hz – 800 Hz). Overall sensitivity, however, is low compared to other taxa (Thomsen *et al.*, 2009).

To date, auditory and non-auditory injuries have not been observed or documented to occur in association with dredging (Thomsen *et al.*, 2009; Suedel *et al.*, 2019). The literature suggests that dredging noise is unlikely to cause direct mortality or instantaneous injury. However, the (predominantly) low-frequency sounds produced by dredging overlap with the hearing range of many fish species, which may pose a risk in Temporary Threshold Shifts (TTS), auditory masking, and behavioural effects (McQueen *et al.*, 2019), as well as increased stress-related cortisol levels in fish species (Wenger *et al.*, 2017). A TTS involves a temporary reduction of hearing capability caused by exposure to underwater noise. An intense short exposure can produce the same scale of TTS as a long-term, repeated exposure to lower SLs. The significance of the TTS varies among species depending on their dependence on sound as a sensory cue for ecologically relevant functions. Furthermore, it is important to note that the biological significance of such responses is largely unknown.

Popper *et al.* (2014) produced a peer reviewed technical report which recommended sound exposure guidelines for fish species relating to continuous noise sources (such as dredging and shipping). The study concluded that the risk of mortality and injury for fish is low. However, there was considered to be a high risk of potential behavioural responses occurring in the direct vicinity of the noise source for fish species considered to be hearing sensitive and a moderate risk in other fish species.

For species that are relatively insensitive, such as demersal flatfish and crustacea (e.g. brown crab and lobsters), strong behavioural reactions are likely to be limited to the immediate vicinity of the dredging operation. These avoidance reactions may reduce the likelihood of direct uptake of these organisms by the dredger. It should be noted however that there is currently relatively limited scientific literature on the impacts of noise on shellfish species (Section 8.3.5). However, as with evidence on benthic invertebrate, more studies are being undertaken to increase the understanding.

Not much is known on the sensitivity of juvenile fish to noise. Popper *et al.* (2014) provides qualitative noise thresholds (for continuous sources) for fish eggs and larvae which indicate that they have the same or less sensitivity than adult fish. For this assessment, it has, as a worst case, been assumed that the sensitivity of juvenile fish is similar to that of their adult counterparts.

With regard to light disturbance/pollution, many behavioural and physiological activities in fish are known to underlie either daily or seasonal rhythms. The European eel, for example, has been found to migrate during dark nights and rest during bright nights around full moon (Stein *et al.*, 2015), and artificial lighting thus has the potential to disrupt the migration of eel and other migratory fish, including salmon (Hansen and Jonsson, 1985; Greenstreet, 1992). There is evidence, for example, that street lighting disrupts the diel migratory pattern of salmon smolts leaving their natal stream (Riley *et al.*, 2012) and also delays the dispersal of salmon fry (Riley *et al.*, 2013). There is also evidence to suggest that lamprey are not particularly sensitive to lighting and will often be attracted to lighting rather than causing a barrier to movements (Stamplecoskie *et al.*, 2012 and Zielinski *et al.*, 2019).

Furthermore, several reproductive traits in fish are controlled by internal clocks and depend on light as an important cue. Fish farmers and scientists have been known to use this to induce off-season spawning in fish that normally reproduce only once per year, or to prevent precocity in commercial aquaculture species (e.g. Carrillo *et al.*, 2009; Macquarrie *et al.*, 1979; Rodríguez *et al.*, 2005). However, this kind of research has predominantly been conducted in the laboratory or in artificial environments with high intensity night lighting (Brüning *et al.*, 2018). It is furthermore thought that daytime feeders might extend their activity under illumination, thus increasing predation pressure on nocturnal species (Hölker *et al.*, 2010).

Impact assessment

The qualitative guidelines for continuous noise sources consider that the relative risk of mortality and potential mortal injury in all fish is low in the near, intermediate and far-field (Popper *et al.* (2014). The cumulative Sound Exposure Level (SEL) thresholds for piling (Popper *et al.,* 2014) can be applied on a precautionary basis to quantify the potential range of effects from dredging noise. Assuming a worst case unweighted RMS SL of up to 188 dB re 1 µPa m for aggregate dredging, and applying a simple logarithmic spreading model with a factor for attenuation of 17.91 and a factor for the absorption of sound in water and boundaries of 0.00523 dB m^{-1}, as has previously been recommended by the Environment Agency (URS Scott Wilson, 2011; ABPmer, 2015), indicate that there is a risk of mortality/ potential mortal injury within around 50 m in fish with a swim bladder involved in hearing, within 30 m in fish with a swim bladder that is not involved in hearing and 10 m for fish with no swim bladder.

According to Popper *et al.* (2014), the risk of recoverable injury is also considered low for fish with no swim bladder and fish with a swim bladder that is not involved in hearing. There is a greater risk of recoverable injury in fish where the swim bladder is involved in hearing (e.g. herring) whereby a cumulative noise exposure threshold is recommended (170 dB RMS for 48 h). The distance at which recoverable injury is predicted in these fish as a result of the dredging using the model and assumptions presented above is approximately 10 m. Applying the cumulative SEL thresholds for piling (Popper *et al.* (2014) on a precautionary basis, indicate that there is a risk of recoverable injury within around 80 m in fish with a swim bladder and 20 m for fish with no swim bladder.

Popper *et al.* (2014) advises that there is a moderate risk of a TTS occurring in the nearfield (i.e. tens of metres from the source) in fish with no swim bladder and fish with a swim bladder that is not involved in hearing and a low risk in the intermediate and far-field. There is a greater risk of TTS in fish where the swim bladder is involved in hearing (e.g. herring) whereby a cumulative noise exposure threshold is recommended (158 dB RMS for 12 h). The distance at which TTS is predicted in these fish as a result of the dredging using the model and assumptions presented above is approximately 50 m. Applying the cumulative SEL thresholds for piling Popper *et al.* (2014) on a precautionary basis, indicate that there is a risk of TTS occurring within around 700 m in all fish.

It is noteworthy that, as outlined in Section 3.4, dredgers would take up to approximately 5 hours per day to load a cargo (whilst continually moving at slow speeds), and that, on average, dredgers are anticipated to spend around 35 h per week at Bedwyn Sands and NMG. Thus, it is highly unlikely that recoverable injury or TTS will occur, especially as fish would be expected to move away from the source. In addition, the actual SL of the proposed dredging activity is likely to be even lower given that sand is to mostly be dredged, which leads to lower noise levels than gravel loads (Robinson *et al.*, 2011).

In addition, Bedwyn Sands and NMG are located in a relatively busy shipping region; as outlined in Section 13, some 14,885 vessel transits per annum take place in the wider study area, with the continued movement of dredging vessels at the Renewal Areas estimated to be less than 4 % of the overall movements in any given year, should a licence be granted.

Popper *et al.* (2014) guidelines suggest that there is considered to be a high risk of potential behavioural responses occurring in the nearfield (i.e. tens of metres from the source) for fish species with a swim bladder involved in hearing and a moderate risk in other fish species. At intermediate distances (i.e. hundreds of metres from the source), there is considered to be a moderate risk of potential behavioural responses in all fish and in the far-field (i.e. thousands of metres from the source), there is considered to be a low risk of a response in all fish.

Overall, there is generally considered to be a low risk of any injury in fish and crustacean shellfish as a result of the underwater noise generated by dredging. The level of exposure will depend on the position of the fish and shellfish with respect to the source, the propagation conditions, and the individual's behaviour over time. However, it is unlikely that they would remain in the vicinity of a dredger for extended periods. TTS and behavioural responses are anticipated to be limited to a relatively localised in scale in the context of the estuary width and the unconstrained nature of the location. As the dredger vessel is moving, fish and shellfish are not physically constrained; they will be able to move away from the source of the noise and return once dredging activity has ceased.

With regard to light, the application for this marine licence is for a 24-hour permit to extract aggregates, during night-time operations artificial lights will be used for safety reasons. It is considered that the proportion of operations that occur at night will be minimal and the area of sea that will be lit up as a result vessel presence will only constitute a small fraction of the total area. Furthermore, it is worth noting that dredging is already taking place in the region, and that the continued dredging at the Renewal areas would not result in an increase in vessel traffic (see Section 13.3.1 for further detail).

Based on these factors, and the low abundances of fish and shellfish in the area, the magnitude of the change due to dredging noise and lighting is considered to be negligible. The sensitivities of fish and shellfish to underwater noise and lighting is considered to range from low (e.g. dab, river and sea lamprey) to high (e.g. herring, allis and twaite shad), whereas sensitivity to light is considered to be low to moderate. The importance of fish ranges from high for fish of high nature conservation status and/or commercial value to low for fish with no protected status and which are not of commercial value. Taking these factors into account, the overall exposure and vulnerability will be negligible and none respectively. Overall, therefore, the impact of dredging noise and lighting is considered to be **insignificant**.

9.3.4 Sandeel assessment

As outlined previously an industry wide approach has been adopted specifically for the assessment of sandeel (A. *marinus, A. tobianus, G. semisquamatus*, *H. lanceolatus* and *H. immaculatus*), which are considered particularly sensitive to aggregate dredging. This work included the production of a detailed method statement by the Marine Aggregate EIA Working Group, in consultation with the MMO and the Regional Advisory Group (RAG) (Reach *et al.*, 2013; Latto *et al.*, 2013). This detailed method statement clarified that EIAs for marine aggregate licence applications will specifically need to consider the following effect-receptor pathways for sandeel (within the PIZ only):

- Direct removal of suitable sediment (habitat); and
- Direct removal of sandeel.

The following pathways are therefore assessed here, which have the potential to impact sandeel:

- Habitat change (structure/habitat) due to seabed removal and screening (incorporating recovery of habitat); and
- Direct removal of sandeel/entrainment of adult sandeel and egg by the dredger draghead.

Habitat change (structure/habitat) due to seabed removal and screening (sandeel)

General scientific context

Sandeels are a vital component of marine food webs, forming a crucial mid-trophic link between zooplankton production and top predators such as fishes, seabirds and marine mammals (Wanless *et al.*, 2004). Sandeel are demersal spawners, with eggs being laid as sticky clumps on sandy substrate; thereafter, sandeel larvae are pelagic for a period of 50 to 90 days (Rogers and Stocks, 2001; Wright *et al.*, 2000). Sandeels adopt a demersal lifestyle by around two months after hatching and overwinter buried in the sand. Tagging experiments have shown that there is little movement between spawning and feeding grounds, indicating that fishing and spawning grounds may coincide (Rogers and Stocks, 2001; Wright and Bailey, 1993). During the summer months (between March and October) sandeels exhibit a daily pattern of emergence, moving up the water column during daylight to feed. The vertical pattern makes them accessible to surface feeding seabirds and other pelagic feeding predators.

The distribution of sandeel is mostly dependent on sediment type, as sandeel do not maintain permanent burrow openings and hence rely on oxygen within the interstitial water (e.g. Holland *et al.*, 2005). For example, A. *marinus* prefers sediments with low silt/clay content, and also has a preference for gravel content of less than 10%, and ideally no more than 2 to 4%. Habitat preference experiments have also found that as the proportion of coarse and medium sand (between 0.25 and 2 mm) in the sediment increases, sandeels show increased selection for the habitat, although slightly gravelly sand may also be suitable (e.g. Wright *et al.*, 2000; Holland *et al.*, 2005). Sandeels prefer to occupy sloping areas of sandbanks facing into currents (Greenstreet *et al.*, 2010), with current speeds being greater than 0.6 m/s. Sandeels have also been shown to have a temperature preference (between 0ºC and 8.3ºC) as well as a preference for stratified saline waters (Wright *et al.*, 1998).

Further information on the ecology of sandeel can be found in Latto *et al.* (2013), where suitable sandeel spawning seabed habitat has been identified based on the available evidence. According to this, sediment classed as 'Sand', 'slightly gravelly Sand' and 'gravelly Sand' on the Folk (1954) sediment classification scale is viewed as 'preferred habitat', and 'sandy Gravel' as 'marginal habitat'.

Impact assessment

As shown in Figure 9-2, the majority of the sediment at Bedwyn Sands and NMG consists of Sand, a 'preferred' habitat for sandeel. However, it should also be considered that only a relatively small percentage of Bedwyn Sands and NMG tend to be dredged in any given year and it is therefore unrealistic to consider that all of these areas will be impacted in any given year, or even over the licence term.

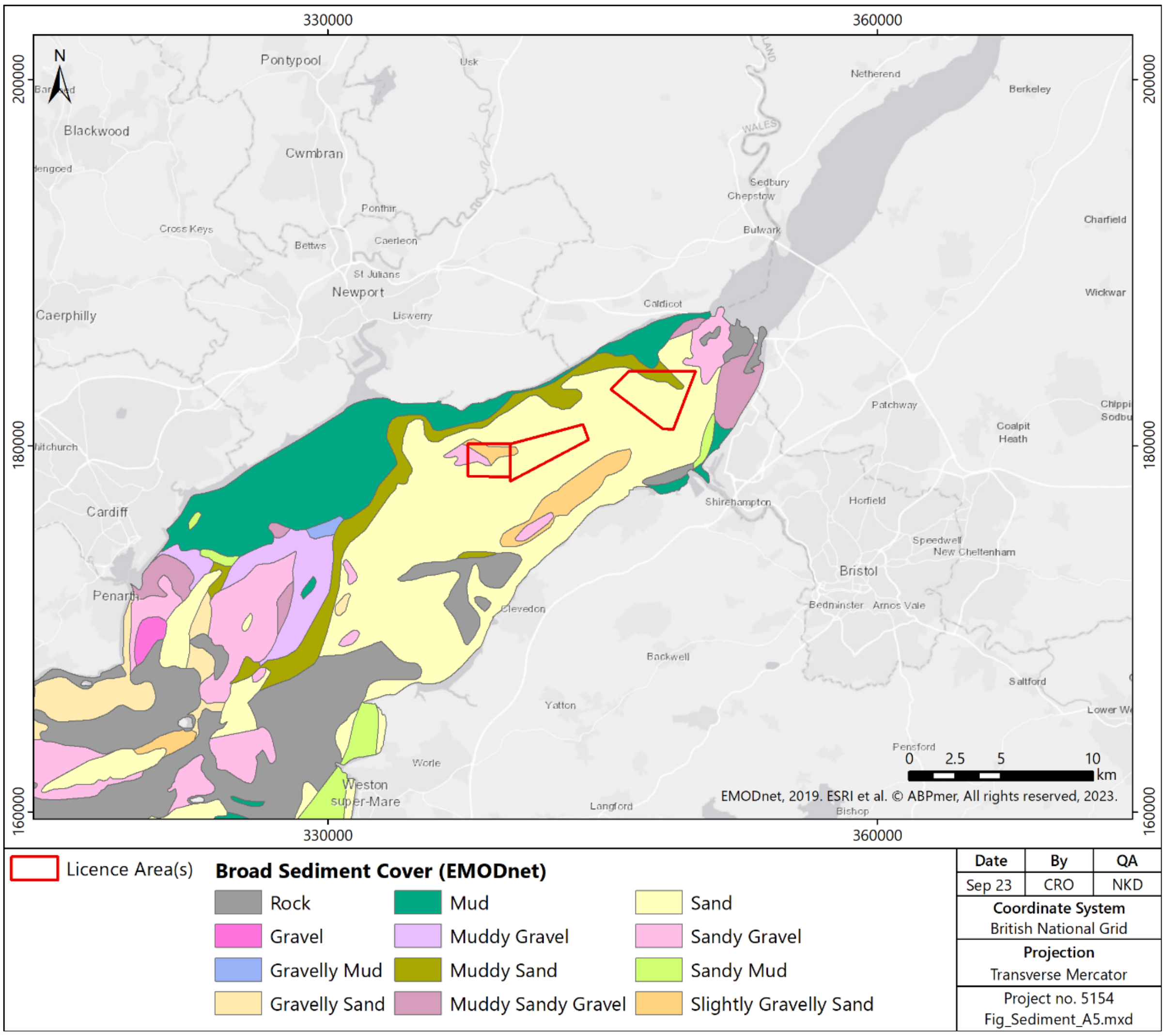

Figure 9-2 Broad sediment types in study area

Only a few sandeel were captured on the NMG in trawl surveys undertaken by Cefas in 1999 and 2000 (HR Wallingford, 2003). In addition, only a single lesser sandeel has been captured in nine years of TraC fish monitoring (2003 and 2007-2014) using otter trawls at Bedwyn Sands near NMG (NRW, 2015). However, it should be noted that these fish surveys were general fish surveys and did not target sandeel species specifically. It is therefore possible that higher abundances could have been recorded in dedicated sandeel surveys e.g. using a dredge. Based on this information, Bedwyn Sands and NMG are not expected to hold important sandeel populations.

In addition to the direct removal of seabed, sandeel sediment habitat could also be reduced if any of the suitable habitat changes during dredging operation. For example screening, which may be practiced in Bedwyn Sands and NMG (see Section 3), could also lead to finer or coarser sediment fractions being excluded from a given dredge load, and could thus lead to habitat becoming too coarse for sandeel. However, screening is not always practiced and unlikely to be of a significant scale that would substantially affect sandeel sediment habitats. In addition, sand is the predominant sediment in Bedwyn Sands and NMG, and sandeel is not considered to be sensitive to the habitat becoming too sandy.

Particularly after an initial larval dispersal period, research suggests sandeel display a degree of site fidelity (Haynes *et al.*, 2011; Jensen *et al.*, 2011). Consideration therefore needs to be given to the state of seabed habitats at the end of the licence term, and whether or not the PIZ has the potential to be re-colonised. It is important to note that, as discussed in Section 5, the trailer dredging activity creates relatively shallow furrows which are often infilled on the next tide, with the bed reverting to something close to its pre-dredged state.

It is worth highlighting standard industry mitigation measures at this juncture, as summarised in Section 3.5 above. Firstly, sediments are not dredged completely (down to bedrock), but a minimum of 0.5 m in depth (on average across the dredge area) is left. Furthermore, the seabed sediment post-dredging is left in a similar physical condition to that present before dredging. Therefore, once a dredger has moved on, whilst the habitat the sandeel may have previously used for burrowing or spawning may have been dredged, there would still be an appropriate layer of suitable sediment remaining. Consequently, it is not expected for there to be any significant long-term habitat change/sandeel habitat loss. It is, therefore, considered that, given the removal of sediment and screening will not lead to habitat change, sandeel would be able to rapidly re-colonise the area which has recently been dredged.

Overall, the probability of a significant adverse habitat change occurring is considered negligible. Furthermore, the magnitude of change would be negligible to small. Consequently, a negligible exposure to change is assessed. Coupled with a moderate sensitivity to localised habitat change, the vulnerability is assessed as negligible, and thus impacts will be **insignificant.**

Direct removal of sandeel/entrainment by the dredger draghead (sandeel)

General scientific context

Sandeel hibernate in sandy sediment between September and March, with the exception of spawning in December and January (Gauld and Hutcheon, 1990; Macer, 1966; Wright *et al.*, 2000). They also overwinter, overnight and rest buried in sandy sediment (normally within 4 to 6 cm of the surface) (Haynes *et al.*, 2011). The response to perceived danger is also burial (Dipper, 2001). These life history traits make this species particularly vulnerable to entrainment by a dredger. For example, sandeel accounted for 92% of all individuals entrained during a four-year study of navigation dredging entrainment (Larson and Moehl, 1990).

However, if entrainment of adult sandeel occurs, research indicates that sandeel can survive entrainment and are often washed back into the sea alive (ABPmer, 2013). Nevertheless, the long-term effects on the entrainment of sandeel of those individuals is not clear, i.e. they could have suffered damage. In addition, this research is considered a one-off study and further detailed research is required in order to verify the findings.

Impact assessment

During aggregate dredging, there is the potential for fish and fish eggs to be directly taken up by the action of the draghead. Dredging often takes place during daytime, and sandeel would thus often be in the water column when dredging takes place, when they can move away from the direct impact. However, sandeel would very frequently be buried in the sediment (whilst resting, during the night and in the colder autumn and winter months). Thus, the likelihood of sandeels being taken up by the dredger is fairly high. Based on the above information, sandeel are likely to be present, in at least low densities, in most areas of suitable habitat across Bedwyn Sands and NMG.

In terms of sandeel eggs, as outlined above, Bedwyn Sands and NMG predominantly consists of potential sandeel 'preferred' habitat sediment. Sandeel spawning is understood to take place between November and February (Cefas, 2001). Should spawning take place on the areas of suitable seabed within Bedwyn Sands and NMG, and dredging coincide with the spawning season, then there is a potential for eggs to be taken up by the draghead in the area of active dredging, and consequently eggs could be lost (i.e. eggs are highly sensitive to uptake).

Overall, it is considered that in any given year or season, relatively small areas of Bedwyn Sands and NMG are likely to be affected. Thus, probability of occurrence can be assessed as low to medium, and magnitude of change negligible to small (as only a very small percentage of the suitable substrate would be affected at any one time), leading to a negligible to low exposure to change. Based on the evidence base presented above, entrainment sensitivity is considered moderate and consequently vulnerability low. Based on a moderate importance, a potentially **minor adverse** impact with regard to direct fish and egg uptake is identified for Bedwyn Sands and NMG.

9.3.5 Herring assessment

As previously outlined, an industry wide approach has also been adopted specifically for the assessment of spawning herring (*Clupea harengus*) which is considered particularly sensitive to aggregate dredging. This work included the production of a detailed method statement by the Marine Aggregate EIA Working Group, in consultation with the MMO and the RAG (Reach *et al.*, 2013). Reach *et al.* (2013) clarified that EIAs for marine aggregate licence applications will specifically need to consider the following effect-receptor pathways for herring in the PIZ and Secondary Impact Zone (SIZ):

The PIZ:

- Direct removal of suitable sediment;
- Direct removal of eggs;
- Alteration of habitat structure; and
- Recovery of suitable habitat to support future possible spawning activity (re-colonisation).

The SIZ:

- Smothering of eggs;
- Fining of suitable habitat; and
- Recovery of suitable habitat to support future possible spawning activity (re-colonisation).

The following pathways are assessed which have the potential to impact herring:

- Egg entrainment by the dredger draghead (PIZ);
- Habitat change (structure / habitat) due to seabed removal (PIZ) (incorporating recovery of habitat);
- Habitat change due to fining of suitable habitat (PIZ/SIZ) (including recovery of habitat); and
- Egg smothering (plume, sediment mobilisation, sand settlement) (SIZ).

Egg entrainment by the dredger draghead (Herring)

General scientific context

Herring eggs are demersal (0.9–1.5 mm in diameter), and the larval and post-larval stages pelagic (Ellis *et al.,* 2012). Herring eggs and larvae can also be an important food source for some predators (Rankine and Morrison, 1989). Herring eggs stick to the seabed substrate by an adhesive mucus produced in the ovary. The depth and substratum of the spawning beds may vary to some extent but, for the most part, herring spawn coastally and on offshore banks, and deposit their eggs on gravel or rocks. The demersal nature of the eggs makes them susceptible to entrainment by the dredger (Reach *et al.,* 2013).

Further information on the ecology of spawning herring can be found in Reach *et al.* (2013), where suitable herring spawning seabed habitat has been identified based on the available evidence. According to this, sediment classed as 'Gravel' and 'sandy Gravel' on the Folk (1954) sediment classification scale is viewed as 'preferred habitat', and 'gravelly Sand' as 'marginal habitat'.

Impact assessment

As shown in Figure 9-2, the majority of the sediment in Bedwyn Sands and NMG consists of Sand, which is not utilised by spawning herring. Furthermore, no nursery or spawning grounds for herring are known to be present in the Severn Estuary (Ellis *et al.*, 2012; Kay and Dipper, 2009).

Overall, due to the likely negligible levels of spawning intensity and lack of potentially suitable habitat sediments in Bedwyn Sands and NMG, the probability of an interaction with a dredger occurring is considered to be negligible. Consequently, exposure to change is assessed as negligible. Whilst sensitivity of eggs would be high, a vulnerability score of 'none' is returned, due to the negligible exposure to change. Thus, an **insignificant** impact on herring is assessed in relation to egg entrainment.

Habitat change (structure / habitat) due to seabed removal (Herring)

General scientific context

Herring move between spawning and wintering grounds in coastal areas and feeding grounds in open water by following migration patterns learned from earlier year classes. Juveniles (up to 2 years) shoal close inshore, while adults are found more offshore. Adults spend the day in deeper water but rise to shallower water at night. The herring matures between 2-9 years. Herring populations are known to use traditional spawning grounds, many of which are along shallow coastal areas (15-40 m depth) or on offshore banks down to 200 m.

Herring spawn on gravel and similar habitats (e.g. coarse sand, maerl, shell) where there is a low proportion of fine sediment and well-oxygenated water. Each population spawns only once a year. This strong affinity to spawn on seabeds consisting of coarse sediment can make herring susceptible to changes in habitat (Reach *et al.*, 201; Ellis *et al.*, 2012). Herring spawning and nursery areas are therefore considered particularly vulnerable to sand and gravel extraction.

Impact assessment

Within the PIZ, seabed removal could potentially lead to a change in seabed habitat (structure), whereby the draghead exposes bedrock or finer layers of sediment. As noted above, no suitable habitat for herring is present within Bedwyn Sands and NMG.

As noted in Section 3.5, best practice mitigation is in place to ensure that the seabed sediment post-dredging is in a similar physical condition to that present before dredging (subject to monitoring in line with the RSMP approach). Sediments are furthermore not dredged completely (down to bedrock), but an adequate depth of suitable material (normally at least 50 cm) is left after cessation of dredging as a 'capping layer'. These mitigation measures primarily facilitate the re-colonisation and recovery of benthic communities (JNCC and Natural England, 2011). The measures should also facilitate the seabed in Bedwyn Sands and NMG to be returned to / left in a similar state after a given licence has expired to that which it currently is in. Thus, no significant long-term loss of potential herring spawning habitat sediments (which in any case are not currently present) is anticipated. Should the seabed sediment in Bedwyn Sands and NMG be changed too much, remedial measures would need to be taken.

With the above-mentioned industry best practice measures, and the likely negligible levels of herring spawning intensity at Bedwyn Sands and NMG, the probability of a significant adverse habitat change occurring is considered negligible. Furthermore, the magnitude of change would be negligible given no 'preferred' sediment areas are present. Consequently, a negligible exposure to change is assessed. Coupled with a moderate sensitivity to localised habitat change, the vulnerability is assessed as negligible, and thus impacts will be **insignificant**.

Habitat change due to fining of suitable habitat (PIZ and SIZ) (incorporating recovery of habitat) (Herring)

General scientific context

Information on the habitat preferences and sensitivity of herring has been described above.

Impact assessment

As previously highlighted (see 'egg entrainment by the dredger draghead (herring)' and Figure 9-2), Bedwyn Sands and NMG do not overlap any potential herring habitat sediments. Only gravel tends to be screened (as noted in Section 8.3), thus sediment outside of the PIZ is unlikely to become sandier.

The likelihood of significant screening-related bedforms or veneers forming outside of the immediate vicinity of Bedwyn Sands and NMG is considered very low (see Section 5). Coarser screened material would be expected to fall out immediately below/adjacent to the dredger and would thus not affect the SIZ. Fines would be expected to be suspended into the water column, and not be deposited on the seabed. Lastly, existing industry mitigation measures and practices are considered to ensure that no significant long-term change to habitat sediments occurs within a PIZ and SIZ.

Therefore, based on the evidence provided above, the probability of significant (long-term) habitat change occurring in the impact zones is considered to be low. The magnitude of change would be negligible due to the absence of any suitable habitat for herring being affected. Thus, a negligible exposure to change is assessed. Consequently, and the impact is thus considered **insignificant.**

Egg smothering (plume, sediment mobilisation, sand settlement) (SIZ) (Herring)

General scientific context

Information on the habitat preferences and sensitivity of herring has been described above.

Impact assessment

As noted above, no suitable habitat for herring is present within Bedwyn Sands and NMG. Herring eggs are therefore not anticipated to be smothered by sediment deposited due to screening and draghead mobilisation where dredging occurs close to the Bedwyn Sands and NMG boundary. As outlined above, this would not be expected to affect a significant percentage of the SIZs. In any case, egg sensitivity to high SSC appears to be limited to the first two hours after release of eggs into the water, during which time the egg/embryo cohesive layer known as the chorion forms (Griffin *et al.*, 2009). If the eggs are exposed to SSC exceeding 250 mg/l during this two-hour window, sediment particles can permanently attach to the chorion. This can lead to increased egg aggregation and significant increases in sub-lethal and lethal effects. Beyond the two-hour window, herring embryos and larvae tolerate high SSCs; with concentrations up to 1,000 mg/l. The strength of egg-substratum adhesion may also be affected.

During dredging operations, potential increases in SSC are expected to be negligible (see Section 6.3.1). Given that there is no suitable herring spawning habitat at Bedwyn Sands or NMG, magnitude is negligible. Due to the seasonal nature of spawning, and the likely negligible levels of spawning intensity and lack of potentially suitable habitat sediments in Bedwyn Sands and NMG SIZ, the probability of an interaction with indirect dredging effects occurring is considered to be negligible. Consequently, exposure to change is assessed as negligible. Whilst sensitivity of eggs would be medium to high, a vulnerability score of 'none' is returned, due to the negligible exposure to change. Thus, an **insignificant** impact on herring is assessed in relation to egg smothering in the SIZ.

9.4 Summary and conclusions

Table 9-7 summarises the impact assessment judgements, presents the final conclusions on overall impacts across all impact pathways, and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 9-7 Fish and shellfish ecology impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, and proposed mitigation measures, fish and shellfish species are considered to be exposed to a negligible to small magnitude of change with a negligible to high probability of occurrence, resulting in a negligible exposure to change for most pathways and receptors. The exception to this is the potential removal of sandeel/entrainment by the dredger draghead, where a negligible to low exposure was assessed.
Estimation of vulnerability	Based on the evidence in this assessment, it is estimated that the majority of species are not overly sensitive to the different dredging pathways. Due to a negligible exposure, the majority of species are considered to have no vulnerability. However, the vulnerability of sandeel to entrainment was assessed as low due to their sensitivity to this pathway.
Estimation of significance	Considering evidence presented in this assessment, the importance of the assessed species ranges from low to high. The potential impacts are considered insignificant for most pathways and receptors. The exception to this is the direct removal of sandeel/entrainment which was assessed as minor adverse at worst.
Conclusion	Bedwyn Sands and NMG provide habitat for a variety of fish and shellfish species. Impacts on fish and shellfish are assessed as **minor adverse** at worst (for direct removal of sandeel/entrainment by the dredger draghead). With regard to mitigation, standard industry measures will be observed, notably the RSMP-type monitoring and retaining a minimum layer of sediment.
Confidence Assessment	There is a wide range of data available on the presence of fish and shellfish species in the study area. However, Cefas nursery and spawning ground data does not extend upstream as far as Bedwyn Sands and NMG. In addition, limited specifically collected sandeel and herring data exists for the Severn Estuary. This assessment is based on a wide range of data sources which provides a good understanding of the pathways. There is therefore a medium to high confidence in the assessment.

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10 Marine and Coastal Ornithology

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on marine and coastal ornithological receptors. Section 10.1 outlines the data sources and consultation used to inform the baseline and assessment. Sections 10.2 and 10.3 respectively cover the baseline and impact assessment relating to ornithological receptors and Section 10.4 provides a brief conclusion.

A definition of the study area applied within this ES is provided in Section 4.1. For the purposes of this assessment the 'immediate study area' comprises both the footprint of the licence applications for Bedwyn Sands and NMG (coinciding with the PIZ) and the potential SIZs as are represented by a 500 m buffer around the footprint of the dredging areas. For the purposes of the assessment for this topic the 'wider study area' refers to the Severn Estuary.

10.1 Data sources and consultation

10.1.1 Data sources

The principal sources consulted in this assessment are as follows:

- Severn Estuary British Trust of Ornithology's (BTO) Wetland Bird Survey (WeBS) Core Counts (covering the five winter periods up to 2021/22 (Austin *et al*., 2023)).
- Severn Estuary WeBS Low Tide Counts: Data for the most recent four count years is summarised (2002/03, 2008/09, 2015/16 and 2016/17).
- Site Specific WeBS Low Tide Counts: WeBS Low Tide counts for sectors that overlap the Renewal Areas for the most recent years surveyed (2002/03, 2008/09, 2015/16 and 2016/17).
- Population Trends for species in the Severn Estuary: Information on long-term trends in the population status of waterbirds in the Severn Estuary is available for the period up to 2016/2017 from the latest WeBS 'Alerts Report' (Woodward *et al.,* 2019a).
- High tide roost study of the Severn Estuary: Analysis of WeBS data from four areas around the estuary (Latham, 2015; Woodward *et al.,* 2016; Link Ecology, 2018).
- Tidal Power Strategic Environmental Assessment Topic Paper: Summary information on waterbirds in the Severn Estuary prepared by the BTO (BTO, 2010).
- European Seabirds at Sea (ESAS): The most comprehensive information on seabird distributions at sea in north-west European areas comes from this database. This is a collaborative dataset with inputs from the Joint Nature Conservation Committee (JNCC), and other north western European organisations.
- Birds of the Severn Estuary and Bristol Channel (Burton *et al*., 2010).
- Foraging Range Data 2012 and 2019 reviews for UK seabirds (Thaxter *et al*., 2012; Woodward *et al*., 2019a and b)
- South West Strategic Area Aerial Surveys (2007): A series of larger scale aerial surveys were undertaken by the Wildfowl and Wetlands Trust (WWT) in 2007 as part of the South West Strategic Area Environmental Assessment (SEA) Area (WWT, 2008).

Within the baseline section, the data from the national monitoring programmes and surveys which are site specific to the Renewal Areas have been reviewed in an iterative manner, with the broader estuary-wide bird populations being described first (Section 10.2.1), and localised bird numbers and distributions in the vicinity of the Renewal Areas being summarised in the site specific section (Section 10.2.2).

10.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES. No specific comments were received in relation to marine and coastal ornithology.

Previous consultation advice received in relation to the Area 531 ES (see ABPmer, 2019) was also considered, as appropriate.

10.2 Review of baseline understanding

10.2.1 Broad (Regional) Overview

The broad baseline overview for the Severn Estuary has been split into the following discrete sections:

- Coastal waterbirds: Waders and waterfowl (collectively referred to as 'waterbirds' in this report) are defined in this study as coastal-living species that feed wholly or mainly within the intertidal environment, rather than birds that spend the majority of their life-history at sea. This includes waders (*Haematopodidae, Recurvirostridae, Burhinidae, Charadriidae* and *Scolopacidae*), *Rallidae* (Coots, Moorhens), *Ardeidae* (Herons, Egrets) as well as some species of duck, geese and swan (*Anatidae*).
- Marine birds: The section focuses on those species that forage wholly or mainly in the marine environment (both offshore and coastal) through either diving or feeding on the water surface. In the UK, these species consist of seabirds (within the families *Procellariidae*–petrels and shearwaters, *Hydrobatidae*–storm-petrels, *Phalacrocoracidae*–cormorants/shags, *Stercoraridae*–skuas, *Laridae*–gulls /terns and *Alcidae*–auks); divers (within the family *Gaviidae*); grebes (within the family *Podicepididae*) and sea ducks.

Statutory designations in the Severn Estuary

The Severn Estuary is an important overwintering site for a diverse range of migratory wildfowl and waders, regularly supporting in excess of 80,000 individuals (Austin *et al*., 2023). The estuary qualifies as a Special Protection Area (SPA) and Ramsar site for supporting passage and wintering bird populations of European and International importance. These designations are reviewed in Section 7. The location and extent of these designated sites within the Estuary is shown in Figure 7-1. Summary information on the abundances of bird qualifying species within the SPA and Ramsar citations are presented in Table 10-1. In addition, several nearby SSSIs have mobile bird features which could be affected, these include the Newport Wetlands, River Usk, and Severn Estuary SSSIs. Table 10-2 lists the waterbird interest features of these SSSIs.

All bird species are protected under the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. This protects all birds, their nests and eggs (a wild bird is defined as any bird of a species that is resident in or is a visitor to the European Territory of any member state in a wild state). All species of naturally occurring birds in the wild state in Europe (applies to birds, their eggs, nests and habitats) are also protected under Directive 2009/147/EC on the conservation of wild birds (The Birds Directive) implemented in the UK through the Habitats Regulations.

Table 10-1 Qualifying bird species in the Severn Estuary SPA and Ramsar site

Internationally Important Populations		
Internationally Important Populations of Regularly Occurring Annex 1 Species		
Site	**Species**	**Wintering Population (5 year mean peak 2017/18-2021/22)**
The Severn Estuary SPA and The Severn Estuary Ramsar Site	Bewick's Swan	98
Internationally Important Populations of Regularly Occurring Migratory Species		
Site	**Species**	**Wintering Population (5 year peak mean 2017/18-2021/22)**
The Severn Estuary SPA and The Severn Estuary Ramsar Site	Gadwall*	282
	Greater White-fronted Goose	156
	Dunlin	23,644
	Common Shelduck	6,447
	Common Redshank	4,555
Internationally Important Assemblage of Waterfowl		
Site	**Importance**	**Wintering Population (5-year peak mean 2017/18-2021/22)**
The Severn Estuary SPA and The Severn Estuary Ramsar Site	Wintering waterfowl assemblage	77,259 waterfowl
* 5-year peak mean from 2017/18-2021/22 for Gadwall was unavailable. Gadwall 5-year peak mean was recorded from 1991-1996		

Table 10-2 Waterbird features of nearby SSSIs

Site	Feature Category	Feature
Gwlyptiroedd Casnewedd/ Newport Wetlands	Breeding birds	Avocet *Recurvirostra avosetta*, Redshank, Lapwing *Vanellus vanellus*, Water Rail *Rallus aquaticus*, Cetti's Warbler *Cettia cetti* and Bearded Tit *Panurus biarmicus*. also Ringed Plover *Charadrius hiaticula* and Little Ringed Plover *C. dubius*.
	Overwintering birds	Shoveler *Anas clypeata*, Black-tailed Godwit *Limosa limosa*, Gadwall *A. strepera*, Wigeon *A. Penelope*, Shelduck *Tadorna tadorna*, Dunlin *Calidris alpina*, Redshank *Tringa totanus*, Whimbrel *Numenius phaeopus* and Curlew *N. arquata*
River Usk (Lower Usk)	Overwintering birds	Teal *Anas crecca*, Greenshank *Tringa nebularia* and Green sandpiper *Tringa ochropus*
Severn Estuary	>20,000 non-breeding waterbirds	>20,000 Non-breeding waterbirds

Site	Feature Category	Feature
	Aggregations of non-breeding birds	Curlew, *Numenius arquata*, Dunlin, Grey Plover, *Pluvialis squatarola*, Redshank, *Tringa totanus*, Ringed Plover, *Charadrius hiaticula*, Shelduck

Waterbirds

The Wetland Bird Survey (WeBS) is the monitoring scheme for non-breeding waterbirds in the UK which is organised by the BTO. WeBS Core Counts are the coordinated monthly counts of waterbirds (wildfowl and waders) on inland and coastal wetlands. They are undertaken generally on high tides, by volunteer counters who submit their data to the BTO for analysis. Therefore, they describe roosting bird numbers in the estuary at high water. When describing the importance of a site for waterbirds, it is standard practice to use the most recent five years of data that are available. A summary of the peak numbers in the Severn Estuary for the period 2017/18 to 2021/22 is presented in Table 10-3.

The most commonly occurring duck species recorded in the Severn Estuary during the WeBS Core Counts were Wigeon and Shelduck, with five-year peaks of 8,089 and 6,447 birds respectively. Both of these bird populations have remained relatively stable or increased in the long term (i.e. the last 25 years) in the Severn Estuary SPA. Numbers of Pintail and Shoveler have declined in the medium term (i.e. last ten years), with Pintail declining by 50%. However, numbers of other duck species (Teal and Tufted Duck) have increased in the long term (Woodward *et al.,* 2019b).

Overwintering Dunlin and Lapwing were the most abundant wading bird species in the WeBS Core Counts. These species have five-year peak means of 25,500 and 10,823 birds respectively. However, the overall number of wintering waders on the estuary has declined. Dunlin has shown around a 25% reduction in numbers in the long term in the Severn Estuary SPA and Lapwing have shown a 35% decline (Woodward *et al.,* 2019a). This echoes trends at a regional and national scale. The decrease in the UK Dunlin populations has been associated with an increase in The Netherlands, implying that a larger proportion of birds from northern breeding populations were wintering on the Dutch Wadden Sea, probably as a result of climatic amelioration (Thaxter *et al.,* 2010a).

Golden Plover and Redshank were also recorded in high abundances (five-year peak means of >3,000 birds). Both of these species have increased in long term numbers (with Golden Plover increasing by 3,400% and Redshank increasing by 88%) in the Severn Estuary SPA. However, national British trends for these species have shown a downward trend during the last decade (Woodward *et al.,* 2019a). Other abundant wader species included Curlew, Oystercatcher, Ringed Plover and Knot (five-year peak means of >1,000 birds).

Table 10-3 Latest High Water WeBS Core Count data for the Severn Estuary (2017/18 to 2021/22)

Taxonomic Group	Species	2017/18	2018/19	2019/20	2020/21	2021/22	5-Year Peak Mean
Duck, geese and swan (Anatidae)	Mute Swan	374	466	412	356	401	402
	Berwick's Swan	122	116	84	78	92	104
	Whitefronted Goose	125	152	131	171	207	157
	Greylag Goose	652	547	560	514	484	551
	Canada Goose	1,101	1,407	2,021	1,549	1,699	1,555
	Barnacle Goose	233	245	233	210	231	230
	Brent Goose	27	16	91	83	72	58
	Shelduck	4,625	6,775	5,059	8,452	7,324	6,447
	Wigeon	7,803	7,456	9,008	5,657	5,885	8,089
	Gadwall	192	214	284	225	181	229
	Teal	2,884	4,368	4,678	2,405	4,923	4,213
	Mallard	1,809	2,714	2,197	2,286	2,444	2,290
	Pintail	643	618	937	398	600	700
	Shoveler	441	509	794	419	515	536
	Pochard	182	151	201	208	118	172
	Tufted Duck	719	888	797	1067	639	822
Waders (*Haematopodidae, Recurvirostridae, Burhinidae, Charadriidae* and *Scolopacidae*	Oystercatcher	1,393	831	896	910	1,033	1,066
	Avocet	453	781	538	540	866	681
	Ringed Plover	838	426	291	1,671	1,170	1,026
	Golden Plover	2,739	4,290	3501	2,780	3,490	3,360
	Grey Plover	215	261	263	597	554	378
	Lapwing	11,641	15,776	8,501	9,864	8,335	10,823
	Knot	1,354	1,498	2,408	1,341	2,016	1,819
	Sanderling	2,512	203	120	352	400	867
	Dunlin	33,741	25,594	14,173	16,220	28,493	25,500
	Black-tailed Godwit	844	1,008	779	852	1,035	904
	Bar-tailed Godwit	108	450	15	20	31	279
	Curlew	3,411	2,680	,2667	2,835	2,975	2,914

Taxonomic Group	Species	2017/18	2018/19	2019/20	2020/21	2021/22	5-Year Peak Mean
	Common Sandpiper	43	42	41	52	37	45
	Redshank	5,163	4,434	3,261	4,164	5,755	4,555
	Turnstone	283	299	500	457	485	435
Herons and Egrets (*Ardeidae*)	Little Egret	225	256	147	182	165	207
	Grey Heron	64	65	94	88	94	81
Rails (*Rallidae*)	Water Rail	30	22	61	45	55	43
	Moorhen	362	300	314	230	197	293
	Coot	558	679	708	656	475	615

Wetland bird survey low water counts

WeBS Low Tide Counts aim to periodically record bird distributions on the major estuaries in the UK. The exposed substrate at low water (i.e. intertidal area) is divided into sectors, enabling the distribution of feeding and loafing birds to be determined in finer detail. Four visits are undertaken over the winter period between November and February. Counts are carried out over a four-hour period across low tide.

As previously described above, it is standard practice to use the most recent five years of data available when describing the importance of a site for waterbirds. The most recent Low Tide Count for the Severn Estuary and its sub-estuaries is 2016/17, with previous Low Tide Counts undertaken in 2002/03, 2008/09 and 2015/16. Table 10-4 presents the peak counts and a summary of distribution for key waterbird species from these surveys.

WeBS Low Tide Counts of the estuary indicate that the highest densities of waterbirds are found along the Gwent shore, from Rhymney and Peterstone to the Welsh Grounds, on mudflats adjacent to the New Grounds at Slimbridge, on the Axe Estuary, and within Bridgwater Bay (Burton *et al.,* 2010).

The most commonly occurring wildfowl species recorded in the Severn Estuary in the WeBS Low Tide Counts was the Wigeon, Teal and Shelduck. This is consistent with the wildfowl species recorded in highest numbers in the WeBS Core Counts which primarily describe roosting birds. Wigeon had a four-year peak mean of 6,449 birds, Teal has a four-year peak mean of 4,099 birds and Shelduck had four-year peak mean of 2,558 birds. Shelduck are widely distributed around the Severn Estuary. Wigeon and Teal are most abundant on the upper sections of the Severn Estuary, and on the smaller estuaries of the contributing rivers.

Dunlin is the most abundant wading bird species recorded in the WeBS Low Tide Counts, with a four-year peak mean of 33,715 birds. This species is distributed throughout the Estuary, with major concentrations occurring on Stert Flats in Bridgwater Bay. Curlews are also widespread, being found in good numbers throughout the Estuary. Grey Plover and Knot favoured the areas around Burnham-on-Sea and Peterstone on the Welsh shore near Newport, whilst Oystercatchers were found from Severn Beach at Bristol southwards to Burnham on- Sea. Redshanks are widespread in winter, but favour river mouths and other sites where there are freshwater inputs into the estuary. High concentrations of Redshank are found at the mouth of the River Parrett at Burnham-on-Sea.

Table 10-4 Winter maximum count from the latest WeBS low tide data for the Severn Estuary (2002/03 to 2016/17)

Taxonomic Group	Species	2002/03	2008/09	2015/16	2016/17	4-Year Peak Mean
Duck, geese and swan (*Anatidae*)	Mute Swan	59	276	84	156	144
	Berwick's Swan	71	180	120	97	117
	Greenland White-fronted Goose			5		5
	European White-fronted Goose	990	507	132	162	448
	Greylag Goose	11	337	318	264	233
	British/Irish Greylag Goose			1	21	11
	Canada Goose	149	526	721	781	544
	Whooper Swan	4				4
	Dark-bellied Brent Goose	11	19	2	13	11
	Light-bellied Brent Goose		14	13	32	20
	Shelduck	3447	2450	1423	2913	2558
	Wigeon	3331	8672	6160	7632	6449
	Chiloe Wigeon	1				1
	Gadwall	85	151	148	143	132
	Teal	1624	4401	4669	5703	4099
	Mallard	1793	2321	1063	1278	1614
	Domestic Mallard				3	3
	Pintail	498	655	560	687	600
	Scaup	4	9	2	8	6
	Shoveler	368	416	302	315	350
	Pochard	28	133	197	32	98
	Common Scoter	15	8		28	17
	Goldeneye	10	8	1		6
	Goosander	3	15	7	13	10
	Tufted Duck	71	324	355	389	285
	Eider		1		1	1
	Egyptian Goose		2			2
	Barnacle Goose		133	194	258	195

Taxonomic Group	Species	2002/03	2008/09	2015/16	2016/17	4-Year Peak Mean
	Tundra Bean Goose		6			6
	Pink-footed Goose				1	1
	Mandarin Duck		3			3
	Long-tailed Duck				1	1
Waders (*Haematopodidae, Recurvirostridae, Burhinidae, Charadriidae* and *Scolopacidae*	Oystercatcher	824	1046	995	834	915
	Avocet	15	7	500	500	256
	Ringed Plover	84	127	92	56	90
	Golden Plover	1215	1440	3881	2624	2290
	Grey Plover	555	343	219	210	332
	Lapwing	12129	9081	5299	7433	8486
	Knot	1703	4066	3700	3721	3298
	Sanderling	127	163	139	192	156
	Dunlin	40720	27136	20599	46404	33715
	Black-tailed Godwit	42	646	240	409	335
	Bar-tailed Godwit	59	87	6	14	42
	Curlew	3615	2612	2853	2423	2876
	Common Sandpiper	4	3	7	6	5
	Redshank	2439	2936	1474	2549	2350
	Spotted Redshank	6	8	2	2	5
	Jack Snipe	3	3	3	8	4
	Snipe	94	140	85	180	125
	Purple Sandpiper	4	12	2	4	6
	Green Sandpiper	1	1			1
	Greenshank	1	6	3	4	4
	Turnstone	274	629	89	135	282
	Little Stint		6	2		4
	Ruff		11	10	10	10
	Grey Phalarope			1		1
	Unidentified wader			1		1
	Unidentified small wader		735	50		393

Taxonomic Group	Species	2002/03	2008/09	2015/16	2016/17	4-Year Peak Mean
	Unidentified medium wader			30		30
Herons and Egrets (*Ardeidae*)	Little Egret	31	46	45	51	43
	Grey Heron	104	65	1	99	67
	Bittern	1		1	3	2
Rails (*Rallidae*)	Water Rail	5	9	17	16	12
	Moorhen	14	326	60	71	118
	Coot	173	740	377	457	437
Gulls (*Laridae*)	Black-headed Gull	9209	16121	12974	10470	12194
	Mediterranean Gull	2	2	2	1	2
	Common Gull	746	2430	1956	1467	1650
	Great Black-backed Gull	205	329	150	106	198
	Herring Gull	2979	6332	3232	1078	3405
	Yellow-legged Gull	4			2	3
	Lesser Black-backed Gull	2403	2899	880	454	1659
	Little Gull			1		1
	Glaucous Gull				1	1
	Kittiwake		1		1	1
	Unidentified Gull		750		100	425
	Unidentified large Gull		166	10	14	63
Other	Little Grebe	18	33	61	55	42
	Great Crested Grebe	5	12	46	33	24
	Cormorant	64	182	182	129	139
	Kingfisher		1	4	1	2

Marine birds

A summary of the ecology, distribution and abundance of marine birds recorded within the Severn Estuary is shown in Table 10-5. This table also includes five-year peak mean counts of seabirds recorded from the most recently available WeBS counts (Core Counts and Low Tide Counts).

The only commonly recorded seabird species in the Severn Estuary are gulls and the Great Cormorant (BTO, 2010). Gulls are generalist feeders, utilising both terrestrial and marine habitats. Black-headed Gull occurs in large numbers throughout the Estuary (with counts of over 8,000 birds recorded annually). This species is the most abundant gull species in the area (WWT, 2008; Austin *et al*., 2014; BTO, 2010). Herring Gull and Lesser Black-backed Gull are also abundant throughout the area, with important breeding populations on Flat Holm and Steep Holm. The Great Cormorant occurs in the largest concentrations around Cardiff Bay, Flat Holm, the Parrett Estuary and the Inner Severn Estuary with a notable breeding population occurring on Steep Holm (BTO, 2010).

Other species of seabird do not breed in the Severn Estuary, with foraging generally restricted to further offshore in the Bristol Channel (WWT, 2008; DECC, 2009). For example, only one Northern Fulmar and no Northern Gannet, species of auk (Guillemot, Razorbill and Puffin), petrels or shearwaters were recorded in the Severn Estuary in any of the recent WeBS or aerial survey counts. These cliff-nesting seabirds generally show a preference for foraging along open coasts and in offshore waters.

Seaducks are recorded in very low numbers in the Severn Estuary, with Goosander, Common Scoter and Goldeneye recorded most commonly (peak WeBS counts of approximately 10-30 birds). These coastal species have an inshore distribution. The Great Crested Grebe and Little Grebe are also recorded inshore along the Severn Estuary (peak WeBS counts of 10 to 70 birds). No divers (*Gaviidae*) have been recorded in any of the recent WeBS surveys or the 2007 aerial surveys (WWT, 2008).

Table 10-5 Summary of the Distribution, Ecology and Abundance of Marine Birds within the Severn Estuary

Species	Mean Max. Foraging Range From Colony[1,] (km)	Foraging Habitat[2]	Diet[2,3]	Foraging Behaviour, Dive Depth[2,3]	Distribution Within South West England and Wales[4, 5, 6]	Distribution and Status Within the Severn Estuary [6,7]	Severn Estuary Counts	
							WeBS Core Count Five Year Peak Mean (2017/18 to 2021/22) [8]	WeBS Low Tide Four Year Peak Mean
Black-headed Gull	18.5	Coastal and offshore	Worms, insects, small fish, crustacea and carrion.	Surface feeder.	Breeds at a number of colonies in low to high numbers. Common resident, winter visitor and passage migrant.	Recorded abundantly throughout. Present throughout the year.		12,194
Great Black-backed Gull	73	Coastal and offshore	Carrion, seabirds, small mammals, fish and shellfish.	Surface feeder, kleptoparasitism and also feeds on other seabirds.	Breeds at a small number of colonies in low numbers. Passage migrant, winter visitor.	Recorded in low numbers throughout.		198
Mediterranean Gull	20	Terrestrial and marine	During breeding season; insects, gastropods, small numbers of fish and rodents. When not breeding: Marine fish, molluscs, insects, berries, seeds, offal.	Surface feeder.	Scarce breeder. Fairly common passage migrant and winter visitor.	Recorded in low numbers.		2
Herring Gull	58.8	Coastal and offshore	Omnivorous-fish, discards, offal.	Splash diver, kleptoparasitism (will also prey on other seabirds and small mammals).	Common breeder. Common resident, winter visitor and passage migrant.	Recorded abundantly throughout. Primarily a winter visitor. A notable breeding population occurs on Steep Holm.		3,405
Lesser Black-backed Gull	127	Coastal and offshore	Omnivorous- fish, discards, offal.	Feeds on the surface or shallow plunge dives. Mainly coastal foraging range in summer.	Breeds at a number of colonies in low to high numbers. Common summer and winter visitor and passage migrant.	Present throughout the year, but primarily in autumn and winter. Notable breeding population on Flat Holm, with smaller numbers on Steep Holm. Abundant throughout the Estuary; with large concentrations around Longney, Frampton.		1,659

Species	Mean Max. Foraging Range From Colony[1] (km)	Foraging Habitat[2]	Diet[2,3]	Foraging Behaviour, Dive Depth[2,3]	Distribution Within South West England and Wales[4, 5, 6]	Distribution and Status Within the Severn Estuary [6,7]	Severn Estuary Counts	
							WeBS Core Count Five Year Peak Mean (2017/18 to 2021/22) [8]	WeBS Low Tide Four Year Peak Mean
Common Gull	50	Coastal and offshore	Worms, insects, carrion, fish, small birds, small mammals, eggs, berries.	Surface feeder.	Passage migrant and winter visitor.	Recorded throughout the Upper Estuary with large concentrations around Sharpness, Frampton, Longney.		1,650
Black-legged Kittiwake	156.1	Coastal and offshore	Sandeel and clupeids.	Surface feeder using dipping or shallow plunge diving.	Breeds at a small number of colonies in low to moderate numbers. Passage migrant and winter visitor.	Occasionally recorded in the outer Estuary.		1
Little Tern	5	Coastal	Small fish such as clupeids and sandeel. Small invertebrates.	Shallow plunge diver and dipper.	Summer visitor and passage migrant.	Rarely recorded		Not recorded
Common Tern	18	Coastal	Small marine and freshwater fish and aquatic invertebrates.	Shallow plunge diver.	Breeds at a small number of colonies in low numbers. Summer visitor and passage migrant.	Occasionally recorded.		Not recorded
Great Cormorant	25.6	Coastal	Feeds on fish such as flatfish, blennies gadoids, sandeel, salmonid and eels.	Pursuit diver. Max 35 m, mean 12.07 m.	Breeds at a number of colonies in low numbers. Resident, passage migrant and winter visitor.	Present throughout the year; notable breeding population on Steep Holm. Widely distributed; largest concentrations around Cardiff Bay, Flat Holm, the Parrett Estuary and inner Severn Estuary.		139
Northern Fulmar	542.3	Coastal and offshore	Sandeel, sprat, zooplankton, squid, fish discards and offal.	Surface feeder. Also splash dives.	Breeds at a number of colonies in low numbers. Common passage migrant, winter visitor and summer visitor.	Rarely recorded.		
Scaup	n/a	Coastal	Bivalves such as mussels, clams and cockles. Periwinkles, *Hydrobia* and other crustaceans.	Diver	Winter visitor and passage migrant.	Rarely recorded.		6

Species	Mean Max. Foraging Range From Colony[1,] (km)	Foraging Habitat[2]	Diet[2,3]	Foraging Behaviour, Dive Depth[2,3]	Distribution Within South West England and Wales[4, 5, 6]	Distribution and Status Within the Severn Estuary [6,7]	Severn Estuary Counts	
							WeBS Core Count Five Year Peak Mean (2017/18 to 2021/22) [8]	WeBS Low Tide Four Year Peak Mean
Eider	21.5	Coastal	Bivalves such as mussels, crabs, starfish and sometimes fish.	Diver	Winter visitor and passage migrant.	Rarely recorded.		1
Common Scoter	n/a	Coastal	Bivalves such as mussels, clams and cockles. Periwinkles, *Hydrobia* and other crustaceans.	Diver	Winter visitor and passage migrant.	Rarely recorded.		17
Goldeneye	n/a	Coastal	Mussels, cockles, crabs, insect larvae, plants	Diver	Winter visitor and passage migrant.	Rarely recorded.		6
Smew	n/a	Coastal	Fish such as plaice, sandeel as well insects	Diver	Winter visitor and passage migrant.	Rarely recorded.		
Red-breasted Merganser	n/a	Coastal	Fish such as cod, sandeel. Insects and crustaceans also consumed.	Diver	Winter visitor and passage migrant.	Rarely recorded.		
Goosander	n/a	Coastal	Fish such as cod, sandeel. Insects and crustaceans also consumed.	Diver	Winter visitor and passage migrant.	Rarely recorded.		10
Little Grebe	n/a	Coastal	Fish, insect larvae and amphibians	Diver	Breeds on lakes and canals, also recorded in sheltered coastal sites.	Widely distributed.		42
Great Crested Grebe	n/a	Coastal	Insects and small fish	Diver	Breeds on shallow, inland lakes, also recorded in sheltered coastal sites.	Widely distributed.		24

1 Woodward *et al* (2019b);
2 Thaxter *et al.*, (2012);
3 Holden and Cleeves (2002);
4 ESAS data;
5 DECC (2009);
6 WWT, 2008;
7 BTO, 2010;
8 Frost *et al.*, 2018

Foraging ranges, where available, have been taken from Woodward *et al.* (2019b)

10.2.2 Site specific baseline

The Renewal Areas overlap with several WeBS Low Tide Count sectors. Bedwyn Sands overlaps with sectors BV774, BV784 and BV813. NMG overlaps with BV749, BV754, BV758, BV763 and BV813. As described in Section 10.2.1, WeBS Low Tide Counts for the Severn Estuary for the most recent four years (2002/03, 2008/09, 2015/16 and 2016/17) was obtained from the BTO. However, individual sectors which make up the Severn Estuary WeBS area are not counted during every Low Tide Count. Table 10-6 presents the peak counts of bird species recorded in these sectors for the available years.

Very low numbers of birds have generally been recorded in the each of the Renewal Areas during the WeBS Low Tide Counts. Both the Renewal Areas primarily overlap with sector BV813. No species of waterbird were recorded in this area, with only gulls present. This would be expected given the species poor macrofaunal community present in this highly dynamic sand environment; this would provide a limited prey resource for feeding waterbirds (Henderson *et al*., 2006; Mettam *et al*., 1997; Burton *et al.*, 2010). Further information on benthic habitats and species is provided in Section 8.

Sectors BV774 and BV784 overlap with the northern and eastern boundaries of Bedwyn Sands respectively. Large numbers of Wigeon and Dunlin (counts of 500 and 860 birds respectively) were recorded in sector BV774. Moderate numbers of Knot, Shelduck and Curlew (count of 50, 77 and 55 birds respectively) and smaller numbers of Redshank (count of 11 birds) were also recorded in this area. Only Curlew, four gull species and Wigeon were present in BV784. Wigeon are vegetarian and feed primarily on algae, eelgrass and other plant matter in estuaries.

Other species recorded in these sectors feed on polychaete worms, bivalves and marine snails (Holden and Cleeves, 2002). Within the mobile sandflats, these food sources do not occur in sufficient quantities to attract large numbers of foraging birds. However, both BV774 and BV784 extend into slightly richer mudflat habitat found along the north and east boundaries of Bedwyn Sands (Henderson *et al*., 2006; Brazier *et al*., 2007). The birds recorded in these count sectors would therefore be expected to be feeding primarily in the areas of mudflat rather than on impoverished sandflat habitat (which covers much of the Renewal Areas).

Birds were also found to be largely absent from the adjacent NMG during Cefas benthic surveys in 1999 and 2000 (HR Wallingford, 2003). This area consists of the same mobile clean sand sediment type as Bedwyn Sands. Sectors BV754, BV758, BV763 overlap with the northern boundaries and BV749 the western boundary of NMG. Gull species and small numbers of wading birds (10 to 40 birds) including Dunlin, Curlew, Redshank and Oystercatcher were recorded in sector BV754. Curlew and Redshank (a count of 20 and 30 birds respectively), gull species as well as small numbers (<40 birds) of waterfowl were recorded in sector BV758. Various gull species, 21 Curlew and four Mallard were present in BV763. Only gulls and three Turnstone were present in sector BV749.

Table 10-6 Bird species recorded at the Renewal Areas during WeBS low tide counts

Taxonomic Group	Species	Sector Code	Peak Count			
			2002/03	2008/09	2015/16	2016/17
Duck, geese and swan (Anatidae)	Wigeon	BV758		25		
		BV774		500		
		BV779	20			30
		BV784			8	
	Mallard	BV758		35		
		BV759				
		BV763	4		4	

Taxonomic Group	Species	Sector Code	Peak Count 2002/03	2008/09	2015/16	2016/17
		BV779	25	50		21
	Shelduck	BV758		16		
		BV774		2	1	77
		BV779		32	6	62
Waders (Haematopodidae, Recurvirostridae, Burhinidae, Charadriidae and Scolopacidae)	Oystercatcher	BV754		10		
		BV774				1
		BV779	1	5		1
	Bar-tailed Godwit	BV779	9			
	Dunlin	BV754		40		
		BV774		250		860
		BV779	20	2500		4470
	Redshank	BV754		17		
		BV758		20		
		BV774		11		1
		BV779	6	80		25
	Curlew	BV754		27		
		BV755	1			
		BV758		30		1
		BV763	7	21		
		BV774	30	19	55	45
		BV779	40	20	106	110
		BV784	2			
	Turnstone	BV749			3	
		BV754		20		
		BV759	8			
		BV779				2
	Knot	BV774		50		
	Grey Plover	BV774				2
		BV779				9
Herons and Egrets (Ardeidae)	Little Egret	BV774			1	
		BV779	1		1	1
	Grey Heron	BV763		1		
Gulls (*Laridae*)	Herring Gull	BV749	18		200	3
		BV754		37		5
		BV758		50		
		BV759	5			
		BV763		150		300
		BV774		10	7	23
		BV775	2			
		BV776	12			
		BV779		34	13	15
		BV784	35		1	14
	Great Black-backed Gull	BV749	29		30	7
		BV758		2		
		BV759	4			
		BV763		3		
		BV774			7	7
		BV775	2			

Taxonomic Group	Species	Sector Code	Peak Count			
			2002/03	2008/09	2015/16	2016/17
		BV776	7			
		BV779			3	1
		BV784			1	
	Lesser Black-backed Gull	BV749	57		170	2
		BV754		2		
		BV759	30			
		BV763				300
		BV774		39	58	21
		BV776	3			
		BV779		24	9	6
		BV781	2			
		BV784	4			
	Black Headed Gull	BV749			1	
		BV754		27		
		BV758		40		
		BV763		100		2
		BV774		2	17	5
		BV779		38	19	1
		BV784			24	
	Common Gull	BV749			4	3
		BV763				4
		BV779		1		
		BV784			6	
	Unidentified Gull	BV754				1
		BV758				4
		BV763				2
	Unidentified Large Gull	BV754				2
		BV763				1
Other	Cormorant	BV776	12			

10.3 Impact assessment

Aggregate extraction within the Renewal Areas has the potential to affect marine birds through the following activities and sources:

- **Draghead:** The removal of substratum and benthos could have potential effects on the food chain and prey availability for protected species and seabird interest features;
- **Overspill:** This could lead to decreased feeding success and prey availability for seabird interest features in areas of increased activity-related turbidity. The ability of visual-feeding could also potentially be reduced in these species;
- **Screening:** This will result in the same, albeit more localised, effects as the overspill (see above); and
- **Vessel presence**: The presence of the dredger may cause a disturbance, including increase in noise and vibration levels which could potentially disturb seabird interest features. As noted in Section 3.4, based upon current demands at average tonnages, there would be 0.6 and 3.0 cargoes per week at Bedwyn Sands and NMG respectively.

Impact pathways not included in the assessment: No pathways have been scoped out of this assessment.

Impact pathways included in the assessment: The key impact pathways relating to ornithology features are addressed in the following sections:

- Potential indirect effects on waterbirds and marine birds as a result of seabed removal (including prey availability for foraging breeding birds using foraging distances specified by Woodward *et al.*, 2019b (Section 10.3.1);
- Potential impacts on the foraging of marine birds due to suspended sediment plumes (Section 10.3.2);
- Potential impacts on the foraging of waterbirds due to fine sand dispersion (including bedform) (Section 10.3.3); and
- Potential impacts of disturbance generated by vessel presence on waterbirds and marine birds (including visual, noise and vibration) (Section 10.3.4).

The assessment envelope for this impact assessment can be found in Section 3.4 (dredging programme).

To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied to determine the significance of effects (Section 3.5).

Throughout the impact assessment, all bird features are considered to be of high importance given the high level of protection they are afforded under a range of UK and international Legislation.

Cumulative/in-combination impacts are assessed in Section 19.

10.3.1 Potential indirect effects on waterbirds and marine birds as a result of seabed removal (including prey availability)

General scientific context

Marine aggregate dredging has the potential to damage marine features which support important bird populations including habitat designated as part of SPAs and Ramsar sites. Reductions in the availability of habitat and access to prey could lead to changes in the way bird species forage, including increased individual stress levels and alterations to individual time budgets owing to travelling further to find food (Scottish Executive, 2007).

Waterbirds

The quality of intertidal habitat as a feeding resource for waterbirds can be highly variable both spatially and temporally. For example, Redshank prey intake and success rate were significantly lower on an area of restored mudflat on the Humber Estuary compared to the adjacent established mudflat. Furthermore, the number of steps taken while foraging and the number of paces per successful feeding event were significantly greater on the restored mudflat (Mander *et al.*, 2013). Therefore, higher energetic costs for waterbirds could occur in areas where habitat change has caused a reduction in prey distribution and density. This may affect local populations in the long-term through impacts on individual fitness (survival, body condition and fecundity).

Loss or severe degradation of intertidal habitat could displace birds and cause them to redistribute either locally or to neighbouring sites. This in turn might affect the birds at those sites through competition and density-dependent mortality. Redshank displaced following the construction of an amenity barrage at Cardiff Bay (South Wales), for example, experienced a poorer body condition and had a lower survival rate after they moved (Burton *et al.*, 2006). Lambeck (1991) found that Oystercatchers displaced following large-scale habitat loss in the Delta region of The Netherlands experienced significantly higher mortality than those originally ringed elsewhere in the Delta, presumably as a result of the increased densities in recipient areas. In summary, waterbirds are considered to have moderate sensitivity to this effect.

Marine birds

The breeding success of some surface-feeding species, such as terns and kittiwakes, is negatively affected by changes in food availability due to the reliance of prey brought to the sea surface (Furness and Tasker, 2000).

Those species with higher burdens to energy costs of flight and foraging (such as auks) may find it harder to increase foraging ranges to more distant prey resources (if such a change were to occur), than for instance, gannets that are generally less sensitive to natural changes in the availability of food and can forage over a much wider area.

Diving species with high wing loading such as cormorants have high energetic cost during flight, thought to be linked with adaptation of wings for underwater locomotion (Gaston and Jones, 1998; Thaxter *et al.,* 2010a). Thus, while they have the potential to forage far from colonies, their typical ranges may be smaller than those of other species, i.e., 20 to 40 km (Thaxter *et al.,* 2010b; Woodward *et al*., 2019b), and they may be less flexible in making changes in the event of reduced prey availability (Enstipp *et al.,* 2006). In summary, diving species are considered to have a moderate sensitivity to this effect, and surface-feeding species have a low sensitivity.

Impact assessment

Waterbirds

The dredging will not change the overall extent of intertidal habitat which is available as a feeding resource to waterbirds on the Renewal Areas. Both Bedwyn Sands and NMG have been shown to consist of a very species poor macrofaunal community which is typical of mobile sandy habitat that dominates these Renewal Areas (Section 8.2.5). The habitat provides a limited prey resource for feeding waterbirds which is reflected in the very low numbers of waterbirds recorded in the study area compared with mudflat habitat close inshore. Benthic species which are present in the sand are well adapted to dynamic sand environments and so any infaunal prey items present would be expected to rapidly colonise the area following dredging (Section 8.3.1). While the northern edges of the Renewal Areas (and northeast of Bedwyn Sands) overlap with some muddier habitat, these are within the dredging exclusion zones. Breedon Group is not requesting a change to these exclusion zones and as such are effectively looking to continue operating within the area in which aggregate dredging is presently licensed (Section 3.5.2).

Magnitude of change is therefore assessed as negligible, leading to a negligible exposure to change. Marine and waterbirds are considered to have a low to moderate sensitivity to changes in foraging habitat (see above). Combined with a negligible exposure to change, this leads to a vulnerability of 'none'. Therefore, despite the high importance assigned to all waterbird receptors, indirect effects, as a result of seabed removal on waterbirds, result in an impact significance of '**insignificant**' being assessed.

Marine birds

Aggregate dredging has the potential to cause impacts to seabed habitats which could cause changes to the prey resources available for species such as seabirds and other diving birds.

The proposed aggregate dredging will not cause a change to the overall extent of habitat available for seabirds and other diving birds. In addition, the foraging ranges of these species encompasses an extensive area which will not be spatially restricted to the dredge footprints. Any changes in foraging habitat and prey resources will therefore represent only a small proportion of habitat available for these species. In addition, impacts to potential prey items of these species[12] were assessed as minor adverse at worst (Section 9).

Magnitude of change is therefore assessed as negligible, leading to a negligible exposure to change. Marine birds are considered to have a low to moderate sensitivity to changes in foraging habitat (see above). Combined with a negligible exposure to change, this leads to a vulnerability of 'none'. Acknowledging the vulnerability of 'none' and the high importance assigned to all marine bird receptors; indirect effects, as a result of seabed removal on waterbirds, result in an impact significance of **'insignificant'** being assessed.

10.3.2 Potential impacts on the foraging of marine birds due to suspended sediment plumes

General scientific context

An increase in suspended sediment concentrations (SSC) may reduce visibility and affect the feeding success of marine birds that forage visually underwater in the water column, particularly pursuit and plunge divers. The foraging abilities and activity patterns of visual underwater predators are strongly influenced by ambient light levels and water clarity. Marine birds have a number of adaptations to help with visual acuity underwater. Seabirds such as terns and gulls that feed at the surface or plunge for food have red oil droplets in the cones of their retinas. This improves contrast and sharpens distance vision, especially in hazy conditions. Underwater pursuit divers such as auks and cormorants have strongly curved corneas and a pronounced capacity for lenticular accommodation. Some species also have an additional nictitating membrane which acts an additional lens underwater (Gill, 1995).

Research has shown that water transparency can be a major factor influencing seabird underwater foraging. For instance, Day *et al.* (2003) found that foraging areas of closely related and sympatrically occurring auk species (*Brachyramphus marmoratus* and *B. brevirostris*) differed mainly in water clarity, with *B. marmoratus* showing a preference for turbid areas and *B. brevirostris* for areas of better water clarity.

Increased turbidity due to suspended inorganic and organic particles can reduce seabird visual acuity underwater. As vision is the primary sense used by seabirds to locate prey underwater, seabirds have been found to sometimes preferentially select sites where their preferred food items are not only abundant but also clearly visible. For example, Stempniewicz *et al.* (2013) found a significant positive correlation between the density of foraging little auks and visual prey availability (VPA). VPA relates the density and proportion of prey to the optical properties of the seawater. Little auks chose areas where prey was both abundant and clearly visible. However, seabirds have also been recorded foraging in very low light levels and poor underwater visibility. Regular *et al.* (2011) recorded common guillemot foraging at night during both moonlit and starlit periods. The research found that diving depth and efficiency increased with nocturnal light intensity, suggesting that night diving is at least partially visually guided. The research hypothesised that guillemot foraging in low light either rely on close-range visual or possibly nonvisual cues to acquire randomly encountered prey.

Plunge divers such as terns might benefit from feeding over turbid water because the small fishes that constitute their prey move closer to the well-lit surface waters, where in turn, the phytoplankton tends

12 Fish are an important food source for many seabirds and divers. Other marine birds including many diving duck species primarily feed on shellfish such as bivalves.

to concentrate. For example, across a turbidity gradient off the south-eastern United States, both number and proportions of plunge-diving species and individuals decreased significantly with increasing water clarity (Haney and Stone, 1988).

Impact assessment

The effects of suspended sediment plumes related to aggregate dredging are considered to be temporary and likely to last, at most, a few hours after the cessation of dredging. Furthermore, the worst-case footprints of the plume are localised, with concentrations within the existing range of natural conditions (i.e. below the maximum levels of suspended sediments experienced during storms); noting the very high naturally occurring background concentrations experienced in the Severn Estuary (see Section 5.2).

Marine birds generally only occur in low numbers in the Severn Estuary and Inner Bristol Channel, with the exception of gull species which utilise both terrestrial and marine habitats. Gulls also do not rely on capturing food solely through diving or surface feeding like many other marine birds. Furthermore, the affected area would only constitute a very small part of the overall foraging range of marine birds. Seabirds and other marine birds are also relatively well adapted to foraging in turbid conditions and therefore not particularly sensitive to the scale of changes in SSC predicted during dredging. Furthermore, in the turbid Severn Estuary, SSC increases would be unlikely to be notable against background levels (see Section 6.3.1).

Hence, whilst the probability of changes in SSC is considered to be high, magnitude of change is assessed as negligible. The exposure to change is therefore considered to be 'negligible' resulting in a vulnerability of 'none'. Thus, resulting in an impact significance of **'insignificant'** being assessed for this pathway.

10.3.3 Potential impacts on the foraging of waterbirds due to fine sand dispersion (including bedform)

General scientific context

Dredging can lead to changes in sediment composition and bedform, potentially smothering of benthic communities. Many intertidal infaunal benthic species provide an important food resource for waterbird species. The sensitivity of benthic species to smothering is discussed in greater detail in Section 8.3.3.

The long-term impact of these effects on waterbirds will partly be dependent the speed of recolonisation of an area by waterbird prey species. For example, Lewis *et al.,* (2003) investigated the recolonisation by benthic invertebrates and the response of estuarine birds after the construction of a pipeline in West Cork, Ireland. The study found that key waterbird prey species such as the ragworm *Hediste diversicolor* and bivalve *Scrobicularia plana* had fully recovered one year after pipeline construction.

Project impact assessment

As noted in Section 8.3.3, at Bedwyn Sands and NMG, in effect, the resource is well sorted sand, with very little gravel. Thus, Breedon Group targets sand at these Areas and only screens gravel, rejecting only around 3% (maximum) of the dredged material (see Section 3.3). Consequently, deposition of sediment as a result of dredging will be highly localised (restricted mostly to the PIZ). In addition, any sediment that settles will not be measurable against background variability and will be rapidly re-dispersed by ambient tidal currents within a very short period of time (Section 5.4.3 and 5.4.4). The benthic assemblage recorded in the study area are generally highly impoverished, providing a limited prey resource for feeding waterbirds (Section 8.2.5). Those benthic species which are present are well adapted to dynamic sand environments and tolerant to sediment deposition (Section 8.3.3). This resulted in an assessment of 'insignificant' for potential effects of sediment deposition on benthic species (Section 8.3.3).

Magnitude of change is therefore assessed as 'negligible', leading to a 'negligible' exposure to change and therefore a vulnerability of 'none'. Therefore, an impact significance of '**insignificant**' is assessed for this impact pathway.

10.3.4 Potential impacts of disturbance generated by vessel presence on waterbirds and marine birds (including visual, noise and vibration)

General scientific context

Disturbance may exclude birds from parts of available habitat, cause birds to cease feeding, decrease the total amount of time available for feeding, or disrupt other behaviour such as breeding. Where disturbance causes birds to take flight, it can increase energy demands and may increase food consumption (Stillman *et al.*, 2007; Kaiser, 2002; Wright *et al.,* 2014). Where there is a repetition of such activities this can result in possible long-term effects such as prolonged displacement from a habitat, loss of weight and condition, and a reduction in reproductive success. This can lead to population level impacts (Stillman *et al.,* 2012).

Disturbance often occurs through a combination of visual and noise stimuli simultaneously, although some occurrences may be through separate visual or noise stimuli. The response levels to visual stimuli generally depend on distance, while the response levels to noise disturbance vary according to the amplitude and the frequency and character of the noise, although this will vary with distance. Response levels also vary considerably between species and as a result of the level of habituation (Stillman *et al.*, 2012, Goss-Custard *et al.,* 2020, Collop, *et al.,* 2016; IECS, 2009; Chatwin *et al.,* 2013).

Research has shown that disturbance to birds from vessel movements generally occurs within 50 to 100 m of a receptor with sensitive sites such as breeding colonies and roosting sites most susceptible to disturbance (IECS, 2009; Chatwin *et al.,* 2013). There is limited data available regarding noise and vibration during dredging, although underwater noise levels are generally comparable to other types of commercial marine traffic. Research suggests that gulls can be highly tolerant to disturbance stimuli with generally only very intensive, prolonged disturbance causing avoidance of foraging or breeding areas (Calladine *et al.*, 2006). When foraging at sea, tern species are also reported to be relatively insensitive to disturbance by shipping activities (Natural England and JNCC, 2019).

Impact assessment

The dredging vessels will only be operating in the Renewal Areas around high water. This allows a safe clearance depth for navigation and dredging in this primarily intertidal area (see Section 3). Therefore, both Renewal Areas will be completely submerged, and no disturbance impacts on foraging waterbirds are anticipated. As previously discussed, very low numbers of marine birds generally use the Severn Estuary, with the exception of gull species which have been recorded in moderate numbers at the Renewal Areas (see Section 10.2.2). Gulls are not considered sensitive to disturbance and will generally quickly become habituated to anthropogenic disturbance sources (Calladine *et al.,* 2006). Consideration is also given to the historic and ongoing dredging vessel movements that occur across the Renewal Areas.

Magnitude of change is therefore assessed as 'negligible', leading to a 'negligible' exposure to change and therefore a vulnerability of 'none'. Therefore, an impact significance of '**insignificant**' is assessed for this impact pathway.

10.4 Summary and conclusions

Table 10-7 summarizes the impact assessment judgements and conclusions and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 10-7 Marine and coastal ornithology impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Exposure to change of relevant bird features to all potential impacts from the dredging is negligible.
Estimation of vulnerability	Ornithology features show a range of sensitivities to different impact pathways (ranging from low to moderate sensitivity). However, the estimation of vulnerability is 'none' for all impact pathways as a negligible exposure to change is assigned across all pathways.
Estimation of significance	The importance of all ornithology features is high. However, the significance is assessed as **insignificant** for all pathways due to vulnerability of 'none' being assigned.
Conclusion	The study area is only used by fairly low numbers of marine birds (with the exception of gull species) and prey resource across the Renewal Areas is poor. Due to the negligible exposure of birds to the potential impacts, the overall effects on ornithology features will be **insignificant.**
Confidence Assessment	There is a wide range of recent bird data available to describe the presence of marine birds in the study area and wider region. In addition, scientific understanding on the magnitude and sensitivity of birds to these impacts is considered to be good. Confidence is therefore considered to be high**.**

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11 Marine Mammals and Turtles

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on marine mammal and turtle receptors. Section 11.1 outlines the data sources and consultation used to inform the baseline and assessment. Sections 11.2 and 11.3 respectively cover the baseline and impact assessment relating to these receptors and Section 11.4 provides a brief conclusion.

A definition of the study area applied within this ES is provided in Section 4.1. For the purposes of this assessment the 'immediate study area' comprises both the footprint of the licence applications for Bedwyn Sands and NMG (coinciding with the PIZ) and the potential SIZs as are represented by a 500 m buffer around the footprint of the dredging areas. For the purposes of the assessment for this topic the 'wider study area' refers to the Severn Estuary and the Bristol Channel, due to the highly mobile nature of these receptors.

11.1 Data sources and consultation

11.1.1 Data sources

The principal sources consulted in this assessment are as follows:

- Special Committee on Seals (SCOS) Annual Report (SCOS, 2021);
- Common and Grey Seal Movements at Sea: The analysis of over 20 years of at-sea movement data and count data (Russell *et al.*, 2017);
- Inter-Agency Marine Mammal Working Group (IAMMWG) Management Units Abundance Estimates, for the seven most common cetacean species found in UK waters: harbour porpoise, bottlenose dolphin, short-beaked common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and minke whale (Hammond *et al.*, 2021; and IAMMWG, 2021);
- SCANS III Data: Cetacean surveys to estimate the abundance of cetacean species in shelf and oceanic waters of the European Atlantic undertaken in 2016 (Hammond *et al.*, 2021);
- Distribution maps of cetacean and seabird populations in the North-East Atlantic (Waggit *et al.*, 2020; Evans and Waggit, 2023);
- At-sea Distribution Data for Grey and Harbour Seals; estimated using data from animal-borne telemetry tags by the Sea Mammal Research Unit (SMRU) (Carter *et al.*, 2020);
- The Identification of Discrete and Persistent Areas of Relatively High Harbour Porpoise Density in the Wider UK Marine Area (Heinänen and Skov, 2015).
- Modelled Distributions and Abundance of Cetaceans and Seabirds of Wales and Surrounding Waters (Evans and Waggitt, 2023).
- Atlas of the Marine Mammals of Wales (Baines and Evans, 2012).

11.1.2 Consultation

Scoping Opinions from NRW (received 3 February 2023) and the MMO (received 17 April 2023) provided details of those items highlighted by consultees which are expected to be fully considered within this ES in relation to marine mammals and turtles. This included the recommendation by NRW TE that harbour porpoise, bottlenose dolphin, grey seal and common dolphin all be considered within the assessment. Furthermore, potential effects on marine mammal prey species would need to be assessed. These are covered within the impact pathways of Section 11.3, prey impacts specifically in Section 11.3.1 below.

11.2 Review of baseline understanding

11.2.1 Overview

Over eighteen species of cetacean have been recorded in Wales and the South West of England since 1990 (Baines and Evans, 2012; Hammond *et al*., 2017). Of these, only five species (harbour porpoise *Phocoena phocoena*, Risso's dolphin *Grampus griseus*, common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and minke whale *Balaenoptera acutorostrata*) are either present at any time of the year or recorded annually as seasonal visitors within the wider region (Baines and Evans, 2012; OSPAR, 2017). Occasional sightings and strandings of other cetaceans such as long-finned pilot whale *Globicephala melas*, fin whale *Balaenoptera physalus* and killer whale *Orcinus orca* have been recorded, although these remain scarce (Reid *et al*., 2003; Solandt, 2007; Baines and Evans, 2012; CSIP, 2016). Modelled densities for bottlenose dolphin to be very low within the Severn Estuary and the Inner Bristol Channel. While common dolphin densities are relatively higher in the Bristol Channel than bottlenose dolphin, they are also very low within the Severn Estuary (Evans and Waggitt, 2023). National Biodiversity Network (NBN) Atlas records for these species corroborate these recent modelling predictions.

In summary, sightings of cetacean species within the Severn Estuary are generally rare and mainly restricted to sporadic sightings of harbour porpoise (Baines and Evans, 2012; Severn Estuary Partnership, 2012; Heinänen and Skov, 2015). Recent work by Evans and Waggitt (2023), based upon 30 years of sightings data, predicts cetacean density distributions to be very low for all species within the Severn Estuary except for harbour porpoise.

With regard to pinnipeds, grey seals *Halichoerus grypus* are regularly recorded in the Bristol Channel and outer Severn Estuary, although usually in small numbers. Records of common (harbour) seal (*Phoca vitulina*) are rare in the Bristol Channel and Severn Estuary (DECC, 2009; Baines and Evans, 2012; DECC, 2016).

Leatherback turtle *Dermochelys coriacea* is the only cheloniid species that is believed to undertake deliberate, seasonal migratory movement to UK waters to feed on gelatinous zooplankton prey (such as the jellyfish *Rhizostoma* octopus). While the species has been recorded in the South West of England and Wales (particularly off Carmarthen Bay, Tremadoc Bay and Cornwall), sightings are generally rare (with an average of 33 leatherback turtle records each year around the UK) and a total of 1,683 sightings between 1910 and 2018 (Botterell *et al.,* 2020). The species is most commonly recorded in the UK in the Celtic Sea and Irish Sea, although sightings are generally infrequent. Leatherback turtles are rarely recorded in the Inner Bristol Channel and Severn Estuary (Houghton and Doyle, 2006; Witt *et al*., 2007a, Witt *et al*., 2007b; Marubini, 2010).

The baseline review for the more immediate study area has, therefore, focused on the only two marine mammal species which occur with any regularity in the Severn Estuary and Inner Bristol Channel, the grey seal and harbour porpoise.

In order to highlight and compare different populations and habitats, data have been analysed at two different spatial scales for each of these species. First, information on the distribution in the Irish Sea and Celtic Sea area is summarised. This is followed by a summary of abundance levels and distribution in the wider study area of the Bristol Channel and Severn Estuary.

11.2.2 Harbour porpoise

Harbour porpoise distribution is restricted to temperate and sub-arctic (primarily 5-14°C) seas of the Northern Hemisphere. The harbour porpoise is the most commonly recorded cetacean in UK waters, primarily occurring on the continental shelf (DECC, 2009; Reid *et al*., 2003), with a population estimated at c. 500,000 in the area between southern Norway and southern Portugal including the waters around Ireland (Hammond *et al*. 2021).

Porpoises favour relatively cool shelf seas in depths of 20-200 m (Evans 2020). However, telemetry studies have shown that animals from West Greenland seasonally migrate into the central North Atlantic west of Ireland in waters exceeding 2,500 m depth (Nielsen *et al*., 2018). In coastal waters, they are often encountered close to islands and headlands with strong tidal currents (Evans *et al.,* 2003 and DECC, 2009). Porpoise mating occurs around October, with births (usually a single calf) from March to August. Harbour porpoise have a varied diet, exploiting seasonally abundant prey from both pelagic and demersal habitats. Small schooling fish including herring and sprat (*Clupeidae*), sandeel (*Ammodytidae*) and members of the cod family (*Gadidae*) are important food sources in UK and Irish waters (Pierpoint, 2008b).

All cetaceans (whales and dolphins) are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. Disturbance in their place of rest, shelter or protection is also prohibited. All species of cetacean are protected under the Habitats Regulations. In addition, harbour porpoise are also listed as an OSPAR threatened species listed in Appendix II of the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) 1982. Harbour porpoise are also a species of principal importance under the Environment (Wales) Act and the NERC Act.

Distribution and abundance in the Celtic and Irish Sea

Within Wales, harbour porpoise are the most numerous and commonly recorded species (Baines and Evans, 2012). IAMMWG (2021) calculated abundance estimates for the Celtic and Irish Sea Management Unit, which indicate a decline in numbers from 98,807 (CV: 0.30; 95% CI: 57,315-170,336) in 2005 to 62,517 (CV: 0.13; 95% CI: 48,324-80,877) in 2016. Within the Irish Sea, almost 9,500 (9,376) were counted in July 2016 during the SCANS-III survey (Hammond *et al*. 2021), indicating a decline in this region also since July 2005 when 15,230 were counted (Hammond *et al*. 2013). During the 1990s, there was significant bycatch in the Celtic Sea (estimated at 6% mortality of the population in the region, and considered unsustainable) (Tregenza *et al*. 1997, Hammond *et al*. 2002). Determination of the age structure of the population from strandings and estimates of mortality rates later also indicated that the population had experienced a decline (Murphy *et al*. 2020).

Distribution and abundance in the Bristol Channel and Severn Estuary

The approaches to the Bristol Channel have been found to support persistently high populations of harbour porpoise (Evans *et al*., 2015; Heinänen and Skov, 2015; IAMMWG, 2015). This is reflected in the designation of this area as a Special Area of Conservation (SAC) in 2019. The site covers much of the north coasts of Cornwall and Devon and stretches across the Bristol Channel Approaches to Carmarthen Bay in Wales (JNCC, 2017). The entire site has been identified as an important area for porpoises during the winter season, and the northern part in Welsh waters is also an important summer area. The site is located approximately 60 km from the Renewal Areas.

Moderate to high densities of harbour porpoise have also been shown to occur throughout much of the Outer Bristol Channel area in both vessel and aerial based surveys (Baines and Evans, 2012). For example, during monitoring undertaken as part of the Atlantic Array Offshore Windfarm application between April 2009 and March 2011, a total of 189 sightings of harbour porpoise were recorded. Peaks in activity occurred during the late summer and also during the winter (Channel Energy Limited, 2012). The study concluded that harbour porpoise in the area occur at comparable levels to similar habitat elsewhere in South West Wales and North Devon (Channel Energy Limited, 2012).

Harbour porpoise have also been regularly sighted in the Outer Bristol Channel during other monitoring. For example, 465 days out of 550 (85%) had harbour porpoise foraging clicks recorded near the footprint of the proposed Swansea Tidal Lagoon, with a seasonal variation with peak detection in late summer (August to October) (Nuuttila *et al.*, 2018). Monitoring has also shown that harbour porpoise are regularly encountered near headlands on the Gower Peninsula, as well as the Somerset and North Devon Coast (Watkins and Colley, 2004; Pierpoint, 2008a; Baines and Evans, 2012; Channel Energy Limited, 2012; Jenkins and Oakley; 2013; DECC, 2016).

Acoustic cetacean monitoring in the Inner Bristol Channel using C-POD recording devices over a 13-month period between December 2010 and January 2012 also recorded moderate to high densities of harbour porpoise. Porpoises were detected on 84% of days in the study area, indicating that porpoises were generally present in the region throughout the study period. A seasonal pattern was seen in the data, whereby porpoises occurred more frequently during the summer and autumn months (July to October) and less frequently during winter and early spring. There was also a small but significant influence of tidal condition on porpoise detection, with the highest detection rates occurring during the ebbing tide and close to low water.

Harbour porpoise are recorded seasonally in the Severn Estuary, although sightings are uncommon (Severn Estuary Partnership, 2012). Based on this information, they would be expected to occur sporadically in the study area.

11.2.3 Grey seal

The grey seal is the larger of the two seal species found in British waters, with males reaching a length of 2.45 m (SCOS, 2013) and a weight over 300 kg (SCOS, 2013, 2020).

In Wales, grey seals are widely distributed. Grey seals predominantly inhabit remote islands and coastlines in Wales, breeding on undisturbed beaches of cobble and boulders or within sea-caves along the coast. Pupping time occurs primarily from August through to December with September generally being the busiest month.

About 34% of the world's population of grey seal is found in Britain. Approximately 36% of the world's grey seals breed in the UK and 80% of these breed at colonies in Scotland, with the main concentrations in the Outer Hebrides and in Orkney (SCOS, 2021). During the 2019 breeding season, the UK grey seal production was estimated at 67,850 (SCOS, 2021). The most recent survey carried out at the beginning of the 2020 breeding season estimated the total UK population to have been 157,300 and is considered to be the current best estimate available (SCOS, 2021).

The IAMMWG identified eleven Seal Management Units (SMUs) appropriate for grey seal in UK waters (IAMMWG, 2013):

- Shetland;
- Orkney and North Coast;
- Moray Firth;
- East Coast;
- South-west Scotland;
- West Scotland;

- Western Isles;
- North-east England (Scottish border to Flamborough Head);
- South-east England (Flamborough Head to Newhaven);
- West England and Wales (from Newhaven, through the SW Approaches, the Irish Sea to the Scottish border); and
- Northern Ireland.

The diet of grey seals in the UK composed mainly of gadoids (mainly whiting and *Trisopterus* species) and flatfish (mainly sole species), along with smaller amounts of herring (Strong, 1996; DECC, 2016).

Seals are protected under the Conservation of Seals Act 1970 (taking effect in England, Scotland, Wales). Grey and common seals are also listed in Annex II of the EU Habitats Directive 1992 and are protected from disturbance both inside and outside the designated sites. In addition, grey seal is listed as an Appendix III species under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979, which prohibits the deliberate disturbance/capture/killing of species and disturbance of their breeding grounds.

Distribution and abundance in the Celtic and Irish Seas

There is an estimated population of approximately 5,000 grey seals in Wales with the latest pup production estimate of 2,250 pups per year born annually (SCOS, 2021).

In North Wales, grey seal distribution at haul-out sites is almost entirely confined to three areas: Ynys Enlli/Bardsey Island and Penrhyn Llyn/Lleyn Peninsula; the West Hoyle Sandbank at the mouth of the Dee Estuary, adjacent to Hilbre Island; and a cluster of localities on Anglesey. The total population size in North Wales was estimated at between 242 and 307 grey seals (Westcott and Stringell, 2003; Westcott and Stringell, 2004; Stringell *et al*., 2013). However, considering seal counts are underrepresented in North Wales, this number may in reality be higher as 279 grey seal pups were born in 2017 (Robinson *et al.*, 2023).

The largest grey seal breeding population in Wales is located along the West Wales coast. Within the West Wales breeding population, the majority of pup production occurs on Ramsey Island, Skomer Island, and along the North Pembrokeshire mainland coast, between St David's Head and the Teifi Estuary (Strong *et al*., 2006; Boyle, 2012, SCOS, 2021). The Pembrokeshire Marine SAC and Lundy Island SAC are the nearest designated sites to the Renewal Areas which include grey seal as a qualifying feature (representing over 2% of annual UK pup production). Grey seal is also a qualifying feature of the Cardigan Bay SAC.

It is thought that there is no or very few grey seal haul out sites around South Wales (SCOS, 2021). However, although grey seal pup production at sites in Southwest England and Wales is not regularly monitored, pup production amongst these sites was estimated at 1,900 in 2012 (SCOS, 2013) and again in 2020 as 1250, although this is a likely underestimate (SCOS, 2020). Whilst pup production estimates could not be produced for the whole Wales SMU, in North Wales specifically (Dee Estuary- Aberystwyth), the latest pup production estimate is 216 pups (SCOS, 2021) and the Southeast England SMU is continuing to increase exponentially (mean estimate c. 75% between 2014 and 2019,) although this is in large part due to increases in Blakeney Point and Horsey (SCOS, 2021).

Grey seals can undertake large ranging seasonal movements. Seal tagging studies have recorded seals making excursions from major haul-out sites in Wales into the Celtic Sea and outer Bristol Channel (Matthiopoulos and Aarts, 2005; Gordon *et al*., 2011; Thompson, 2012, Carter *et al.,* 2020). Research using photo identification methods has also found evidence of interchange between seals found at Skomer Island, Pembrokeshire and sites in West Cornwall, a distance of over 170 km (Boyle, 2012). Kiely *et al*. (2000) recorded grey seals travelling freely across the Irish Sea, with animals being recorded at sites on the East and Southeast coasts of Ireland and in Southwest Wales.

Grey seals tagged in southwest Ireland were also recorded undertaking large ranging movements along the west coast of Ireland, some travelling at far as 700 km (Cronin, 2011). While grey seals may range widely between haul out sites, tracking has also shown that most foraging probably occurs within 100 km of a haul-out site (SCOS, 2021). For example, Cronin *et al*. (2013) found that foraging trips of tagged seals were present on average approximately 50 km from haul out sites in southwest Ireland. McConnell *et al*. (1999) found that most tagged grey seals stayed relatively close to haul out sites (mean distance of 39.8 km travelled on a foraging trip) with an average of 43% of the grey seals time spent within 10 km of a haul-out site.

Distribution and abundance in the Bristol Channel and Severn Estuary

Grey seal are regularly observed in the Bristol Channel, although usually in small numbers. During the Atlantic Array Offshore Wind Farm development baseline surveys, grey seal accounted for 7% of all marine mammal sightings (42 sightings). Grey seal sightings were widespread, with no evidence of clustering at any particular location (Channel Energy Limited, 2012).

The main grey seal breeding population in the Bristol Channel is located at Lundy Island (North Devon). Westcott (2010) estimated that typically 125 grey seals were present at Lundy Island with the number of animals varying little throughout the year. Annual pup production, currently, appears to be 40 – 45 (26-32% of the population), probably varying from year to year according to sea conditions (Westcott, 2010, SCOS 2020 (43 pups born in 2019).

Models of predicted marine usage by foraging grey seals in the Bristol Channel found this to be highest in the waters around Lundy Island, but usage was generally low throughout much of the rest of the Bristol Channel (Jones *et al.,* 2015).

Grey seals are only occasionally recorded in the Severn Estuary. For example, the Bristol Regional Environmental Records Centre recorded 18 sightings of grey seal around Steep Holm between 1994 and 2010 (Bertelli and Gray, 2015). Based on this information, grey seal would be expected to occur sporadically in the study area.

11.3 Impact assessment

Dredging activities at the Renewal Areas have the potential to affect marine mammals through the following activities and sources):

- **Draghead:** The removal of substratum and benthos could have potential effects on the food chain and prey availability for marine mammals;
- **Overspill:** Decreased feeding success (reduced ability to locate prey visually) and prey availability could occur in areas of increased activity-related turbidity;
- **Screening:** This could result in the same, albeit more localised, effects as the overspill (see above); and
- **Vessel Presence**: The presence of the dredger may cause an increase in noise and vibration levels which could potentially disturb marine mammals. The presence of the dredger also presents the potential for death or injury to marine mammals due to collision with dredging and other activity-related vessels, as well as prompting a behavioural or stress related response. As noted in Section 3.4, based upon current demands at average tonnages, there would be 0.6 and 3.0 cargoes per week at Bedwyn Sands and NMG respectively (and up to 4.4 cargoes at each under the worst-case scenario).

This assessment accounts for the mobile nature of marine mammals within and around the Renewal Areas and focuses on species that have been identified as more commonly occurring within the region, specifically grey seal and harbour porpoise, rather than those species that are considered rare visitors to the estuary.

Impact pathways/receptors not included in the assessment:

- All pathways have been taken forward for assessment.
- Turtles and all marine mammals, except harbour porpoise and grey seal, have been screened out as they are rarely recorded within the Severn Estuary.

Impact pathways included in the assessment:

- The key impact pathways relating to marine mammals which are addressed in the following sections are:
  - Potential impacts to marine mammals due to the removal of seabed (Section 11.3.1);
  - Potential impacts to marine mammals from reduced water clarity due to the suspended sediment plume (Section 11.3.2);
  - Potential disturbance to marine mammals due to the noise and vibration effects (Section 11.3.3); and
  - Potential collision risk to marine mammals due to vessel movements (Section 11.3.4).

The assessment envelope for this impact assessment can be found in Section 3.4 (dredging programme).

To facilitate the impact assessment process and ensure consistency in the terminology of significance, a standard assessment methodology has been applied to determine the significance of effects (Section 3.5).

Throughout the impact assessment all marine mammal species are considered to be of high importance given the high level of protection they are afforded under a range of UK legislation.

11.3.1 Potential impacts to marine mammals due to the removal of seabed

General scientific context

The removal of sediment and associated benthos has the potential to indirectly affect the availability of prey species on which marine mammals feed. This may impact on the feeding success of those species that depend on the seafloor for prey. Foraging areas are a critical habitat for marine mammals; with a critical habitat understood to be 'a place or area regularly used by a cetacean group, population or species to perform tasks essential for survival and equilibrium maintenance' (Clark *et al.*, 2010). Marine mammals utilise very large ranges typically to undertake foraging but can often be aggregated in 'hotspot' areas where key prey resources are found in high densities (Heinänen and Skov, 2015; Nuuttila *et al.*, 2018).

For example, important foraging habitat for harbour porpoises includes areas of strong tidal currents, usually near islands or headlands, where the currents combine with the seafloor topography to create conditions where a higher abundance of prey are recorded (Pierpoint, 2008a; DECC, 2009; Gilles *et al.*, 2016).

Marine mammals feed on a wide variety of prey, in a range of water depths, across a large spatial area. For example, harbour porpoises typically forage on a variety of pelagic and semi-pelagic shoaling fish species such as herring, sprat and sandeel but also feed on demersal species such as gadoids and flatfish. Grey seals are generalist feeders whose diet includes flatfish, gadoids (such as whiting and cod) and sandeels. Both species' diets are known to vary seasonally and from region to region, which makes them more adaptable to accommodating potential localised changes in prey availability (Pierpoint, 2008b; Strong, 1996).

Impact assessment (grey seals and harbour porpoises)

The Renewal Areas overall represent a very small area in the context of the known foraging ranges of harbour porpoise and grey seal. These species also have a limited presence in the Severn Estuary, occurring sporadically rather than regularly (see Section 11.2.2 and 11.2.3). Magnitude of change is therefore assessed as negligible, leading to a negligible exposure to change. Marine mammals are considered to have a moderate sensitivity to changes in foraging habitat. This is based on the information provided in the scientific review which suggests that local distribution is often strongly related to prey habitat and mammals can therefore be particularly susceptible to changes or loss of key foraging habitat. However, given the intertidal nature of the Renewal Areas and highly mobile substrata, the Renewal Areas do not provide important foraging habitat for marine mammals. Given the resulting vulnerability of 'none', the potential overall impact is assessed as **insignificant.**

11.3.2 Potential impacts to marine mammals from reduced water clarity due to the suspended sediment plume

General scientific context

Marine mammals are known to have acute hearing capabilities which allow them to function as predators in low visibility, turbid conditions. Seals only use passive listening, while odontocetes (toothed whales) are known to use both passive and active listening when navigating and foraging (echolocation). For example, harbour porpoise produce short ultrasonic clicks (130 kHz peak frequency, 50-100 µs duration (Teilmann *et al.*, 2002) and are able to orientate and find prey even in complete darkness. Porpoises tagged with acoustic data loggers indicate that they use their echolocation almost continuously (Akamatsu *et al.,* 2006; Nuuttila, *et al.*, 2018).

Marine mammals have well developed underwater vision which allows them to operate in low light levels (Scottish Executive, 2007). Seals hunting in poor visibility waters also use fish-generated water movements for locating prey, which they can detect using their highly sensitive mystacial vibrissae (Hanke and Dehnhardt, 2013; Schulte-Pelkum *et al.,* 2007). Marine mammals are therefore considered to be well adapted to living in areas with a high suspended sediment load and are recorded in such environments in the UK, e.g. estuaries and tidal steams.

Impact assessment (grey seals and harbour porpoises)

The Renewal Areas overall represent a very small area in the context of the known foraging ranges of harbour porpoise and grey seal. These species also have a limited presence in the Severn Estuary, occurring sporadically rather than regularly (see Section 11.2.2 and 11.2.3). The effects of suspended sediment plumes are considered to be temporary and likely to last at most a matter of minutes after the cessation of dredging. Furthermore, the worst-case footprints of the plume are localised, with concentrations within the existing range of natural conditions (i.e. below the maximum levels of suspended sediments experienced during storms) (see Section 5).

Hence, whilst the probability of changes in suspended sediment concentration (SSC) is considered to be high, magnitude of change is assessed as negligible. The exposure to change is therefore negligible. Due to the physiological traits of the receptors highlighted above, marine mammals are well adapted to turbid conditions and therefore not sensitive to the scale of changes in SSC predicted during dredging. Acknowledgment is given to the very mobile nature of marine mammals, allowing these receptors to easily avoid areas affected by the plume and return after the sediment has settled.

Given the resulting vulnerability of 'none', the potential overall impact is assessed as **insignificant** for this impact pathway.

11.3.3 Potential disturbance to marine mammals due to the noise and vibration effects

General scientific context

The increased noise and activity during dredging activities could lead to potential behavioural and stress related reactions in marine mammals. Factors such as age, condition, sex, behaviour, season and social state influence the level of stress experienced (Thomsen *et al.*, 2009).

As previously discussed in Section 9.3.3, aggregate dredging produces broadband and continuous sound[13], mainly at low frequencies of less than 500 Hz and moderate RMS SLs from around 150 to 188 dB re 1 µPa m (Thomsen *et al.*, 2009; CEDA, 2011; Robinson *et al.*, 2011; WODA, 2013; MMO, 2015; Jones and Marten, 2016).

Noise attenuation from source depends upon a number of environmental factors, including the level of background noise at a site. For this reason, the effects of dredging noise on sensitive receptors vary significantly from site to site. Moreover, limited data exist regarding underwater noise production during dredging operations and the effects on marine mammals. The source sound pressure levels associated with aggregate dredging are unlikely to cause mortality or physical injury to marine mammals (Southall *et al.,* 2007; Todd *et al.*, 2015). To date, auditory and non-auditory injuries have not been observed or documented to occur in association with dredging (Thomsen *et al.*, 2011).

There is a scarcity of studies quantifying behavioural impacts from dredging (Thomsen *et al.*, 2011), with documented effects limited to behavioural changes in grey and bowhead whales (Richardson *et al.*, 1995), and an investigation by Diederichs *et al.* (2010) showing that harbour porpoises temporarily avoided an area of sand extraction off the Island of Sylt in Germany. Diederichs *et al.* (2010) found that, when the dredging vessel was closer than 600 m to the porpoise detector location, it took three times longer before a porpoise was again recorded than during times without sand extraction. However, after the ship left the area, the clicks resumed to the baseline rate. Given that sound transmission differs substantially between sites, the distance of 600 m is only valid for this specific dredging project and cannot be generalised to other dredging projects (Thomsen *et al.*, 2011).

National Oceanic and Atmospheric Administration (NOAA) (2018) provides technical guidance for assessing the effects of underwater anthropogenic (human-made) sound on the hearing of marine mammal species. Specifically, the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources are provided.

Further recommendations have recently been published regarding marine mammal noise exposure by Southall *et al.* (2019) which complement the NOAA (2018) thresholds and also look at a wider range of marine mammal species, as well as the hearing sensitivity of amphibious mammals (e.g. seals, sea otters) to airborne noise.

NOAA (2018) and Southall *et al.* (2019) provide weighted cumulative SEL acoustic thresholds for non-impulsive sources (e.g. dredging) which are categorised according to marine mammal hearing groups.

[13] Continuous sound is defined here as a sound wave with a continuous waveform as opposed to transient/pulsed sounds such as pile driving that start and end in a relatively short amount of time.

The relevant acoustic thresholds for the onset of Temporary Threshold Shift (TTS) and PTS due to dredging for the relevant marine mammal groups are presented in Table 11-1.

Table 11-1 Marine mammal response criteria applied in this assessment

Marine Mammal Hearing Group	Non-Impulsive (Vibro Piling, Dredging and Vessel Movements)	
	TTS	PTS
High-frequency (HF) cetaceans (harbour porpoise)	153 dB SELcum	173 dB SELcum
Phocid pinnipeds in water (PW) (true seals)	181 dB SELcum	201 dB SELcum
Weighted cumulative SEL has a reference value of 1 µPa²s.		

Cumulative Sound Exposure Level (SEL) assumes that the animal is stationary within the zone of potential effect for a 24-hour period which is highly unlikely. Furthermore, it does not take potential physiological or physical recovery from any effects of a single signal exposure into account. As such, this averaging metric has the potential to result in false conclusions on the effects of sound exposure and needs to be treated with more caution as noted by Hawkins and Popper (2017).

There are no equivalent Sound Pressure Level (SPL) behavioural response criteria that would represent the sources of underwater noise associated with the proposed development. Behavioural reactions to acoustic exposure are less predictable and difficult to quantify than effects of noise exposure on hearing or physiology as reactions are highly variable and context specific (Southall *et al.*, 2007). A number of field observations of harbour porpoise and pinnipeds to multiple pulse sounds have been made and are reviewed by Southall *et al.* (2007). The results of these studies are considered too variable and context-specific to allow single disturbance criteria for broad categories of taxa and of sounds to be developed. A review of the limited field studies investigating the potential behavioural effects of dredging noise on marine mammals is provided above.

Impact assessment (grey seals and harbour porpoises)

NOAA's user spreadsheet tool (NOAA, 2021) has been used to predict the range at which the weighted cumulative SEL acoustic thresholds (NOAA, 2018) for PTS and TTS are reached during aggregate dredging. In accordance with the guidance provided in NOAA's user manual and the instructions included within the user spreadsheet, 'Tab C: Mobile source, non-impulsive, continuous ("safe distance" methodology)' was selected as the most appropriate method to apply for the dredging and vessel activity. The model input values, and associated assumptions are included in Table 11-2.

Table 11-2 NOAA user spreadsheet tool input values for 'Tab C: Mobile source, non-impulsive, continuous ("safe distance" methodology)'

Model Inputs	Value	Assumptions
Weighting factor adjustment (kHz)	2.5	The maximum recommended default value provided in the user spreadsheet (NOAA, 2021) that leads to the greatest predicted ranges for PTS and TTS and is, therefore, considered a worst case.
Source Level (L_{rms})	188	The *maximum* estimated RMS SL for aggregate dredging (see Section 9.3.3).
Source velocity (m/s)	1	Value is based on the minimum sailing speed of an aggregate dredging vessel as it removes material from the seabed. A lower source velocity value predicts greater ranges at which PTS and TTS are reached and, therefore, the lowest reasonable source velocity associated with the dredging has been applied as a worst case.

The distances at which PTS and TTS in marine mammals are predicted to occur during dredging associated with the construction and operation of the proposed development are included in Table 11-3.

Table 11-3 Approximate distances (metres) marine mammal response criteria are reached during dredging

Marine Mammal Hearing Group	PTS	TTS
Low-frequency (LF) cetaceans	<1	24
Mid-frequency (MF) cetaceans	<1	<1
High-frequency (HF) cetaceans (harbour porpoise)	<1	44
Phocid pinnipeds (PW) (grey-seal and common seal)	<1	12

There is predicted to be no risk of PTS in any of the marine mammal groups. The risk of TTS is limited to within less than 44 m from the dredging activity for harbour porpoise and less than 12 m for grey seal (Table 11-3). Overall, there is unlikely to be any risk of injury or significant disturbance to marine mammals from the proposed dredging.

Based on previous field studies reviewed above, there may be some mild behavioural effects. However, it is generally assumed that marine mammals are unlikely to remain in close proximity to dredging operations for extended periods of time. Given the large foraging ranges of harbour porpoise and grey seal and their high mobility, these receptors are easily able to temporarily avoid the relatively localised areas around aggregate vessels in which underwater noise is at a level which could cause behavioural responses. Furthermore, the activity will be intermittent and there will be extended periods over any 24-hour period when the activity will not be taking place. Noise generated during dredging is, therefore, not anticipated to affect the migratory routes of marine mammals or exclude species foraging in the study area. Noting, see Section 11.2.1, that the Renewal Areas and much of the immediate surrounding area are dominated by intertidal and highly mobile sedimentary features. As such, the habitats within and around the Renewal Areas do not provide important foraging habitat for marine mammals and other receptor groups. It must be acknowledged that Bedwyn Sands and NMG are also located in a relatively busy shipping region. Therefore, it is likely that animals present in the vicinity will already be subject to elevated noise levels and would be expected to show some level of tolerance (to some degree) towards disturbance at the site.

The probability of occurrence for a change in underwater noise levels during dredging is considered to be high. However, there is not considered to be any risk of injury or significant disturbance to marine mammals and the main effect that could be expected in the vicinity of the dredge vessels would be short-term mild behavioural avoidance. Based on these factors, magnitude of the change due to dredging noise is considered to be negligible, resulting in a 'negligible' exposure to change. The sensitivity of marine mammals to dredging noise is considered to be low resulting in a vulnerability of 'none'. Overall, therefore, the impacts of dredging noise on marine mammals (harbour porpoise and grey seal) are assessed as **insignificant.**

11.3.4 Potential collision risk to marine mammals due to vessel movements

General scientific context

Seals and cetaceans can potentially collide with vessel propellers and machinery, possibly leading to physical injury (such as propeller wounds) and, in the worst cases, fatalities (ASCOBANS, 2003; Pace *et al.*, 2006).

Marine mammals have quick reflexes, good sensory capabilities and fast swimming speeds (over 6 m/s for harbour porpoise). These species can also be very agile (Carter, 2007; Hoelzel, 2002). These are all attributes which increase the chance of close-range evasion with an object that could cause a collision risk. However, there have been a number of reported incidents of mortality or injury of cetaceans caused by vessels in UK waters, particularly with inquisitive bottlenose dolphins (WDCS, 2009). In addition, several cases of seal mortality, thought to be caused by ducted propellers and azimuth thrusters (used for the dynamic positioning of vessels) have also been reported in recent years (Thompson *et al.,* 2010; Bexton *et al.*, 2012). However, these cases which have been characterised by a spiral laceration 'corkscrew injury' are now thought to have been caused by predation by other seals (Thompson *et al.,* 2015).

In general, incidents of mortality or injury of marine mammals caused by vessels remain a very rare occurrence in UK waters (ABP Research 1999; CSIP, 2020). For example, out of 144 postmortem examinations carried out on cetaceans in 2018, only two (1.4 %) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (CSIP, 2020).

Reduced perception levels of a collision threat through distraction, whilst undertaking other activities such as foraging and social interactions, are possible reasons why collisions are recorded in marine mammals (Wilson *et al.,* 2007). Juvenile grey seal pups, which are inexperienced in the water, are likely to be particularly vulnerable to collision risk. Marine mammals can also be very curious of new foreign objects placed in their environment and so curiosity around an object could also increase the risk of collision.

Marine mammals are relatively robust to potential strikes, as they have a thick sub-dermal layer of blubber which would defend their vital organs from the worst of any blows (Wilson *et al.,* 2007). Nevertheless, a direct collision with a sharp object such as a moving blade still has the potential to cause injury to marine mammals.

Although all types of vessels may collide with marine mammals, vessels traveling at speeds over 10 knots are considered to have a much higher probability of causing lethal injury (Schoeman *et al.,* 2020; Laist *et al.*, 2001).

Impact assessment (grey seals and harbour porpoises)

The probability of a collision occurring is low as, while collision incidents have been recorded in the UK, they are generally considered to be a rare occurrence. Furthermore, vessels involved in dredging are either likely to be stationary or travelling at relatively slow speeds (typically around 2-5 knots) which will help minimise potential collision risk although it is acknowledged that boat speeds could be higher during travel to/from the site. Noting that in Welsh waters, vessels are encouraged to avoid speeds of more than 6 knots, as advised in the NRW Sea Wise Code (NRW, 2013). Lastly, harbour porpoise and grey seal are recorded only sporadically in the Severn Estuary.

The magnitude of change is therefore assessed as small and the probability low, leading to a negligible exposure to change. Based on the information provided in the scientific review above, marine mammals (both adults and juveniles) are considered to have a moderate sensitivity to collision during dredging activities given that vessels will be mainly stationary or travelling at low speeds. This results in a vulnerability of 'none'.

Thus, the potential impacts of collision on marine mammals (harbour porpoise and grey seal) are assessed as **insignificant.**

11.4 Summary and conclusions

Table 11-4 summarises the impact assessment judgements and conclusions and also provides an indication of the confidence in the respective assessments and evidence base.

The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 11-4 Marine mammals impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Exposure to change of relevant marine mammal features to all potential impacts from the dredging is negligible.
Estimation of vulnerability	Marine mammals show a range of sensitivities to different impact pathways (ranging from none to a moderate sensitivity). However, the estimation of vulnerability is 'none' for all impact pathways as a negligible exposure to change is assigned across all pathways.
Estimation of significance	Given the protection afforded to these species, the importance of all marine mammals is high. The significance of all pathways is assessed as **insignificant** due to vulnerability of 'none' being assigned.
Conclusion	Marine mammal species are sighted sporadically in the Severn Estuary, and there is no indication that the Renewal Areas provide important habitat or prey to support them. Marine mammals are also highly mobile and can easily avoid active dredging areas. Impacts on grey seals and harbour porpoises only were assessed (all other species were scoped out). In summary, it has been concluded that any effects on marine mammals will be **insignificant** and no mitigation is required.
Confidence Assessment	There is a wide range of recent marine mammal data available on the densities and distribution of marine mammal species in the Bristol Channel although data is more limited for the Severn Estuary. However, scientific understanding on the magnitude of the impacts and sensitivity of marine mammals is good. Confidence in this assessment is therefore considered to be **medium**.

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12 Commercial and Recreational Fisheries

This section assesses the effects of continued aggregate dredging in Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) in the Severn Estuary on commercial and recreational fisheries.

The section commences with a presentation of the data sources and organisations/stakeholders consulted to inform the baseline and assessment (Section 12.1). Sections 12.2 and 12.3 cover the baseline and impact assessment relating to fisheries. Section 12.4 provides a brief conclusion. Details on the ecology of fish and shellfish species are found in Section 9.

A definition of the study area applied within this ES is provided in Section 1. However, to align with availability of fisheries data, the study area in this Section is defined as the International Council for the Exploration of the Sea (ICES) rectangles 31E7 and 32E7, which cover an area of the Severn Estuary inland from the mouth of the river Usk (see Figure 12-1). ICES rectangle 31E6 was scoped out because its edge is approximately 5 km beyond NMG and so outside of the potential impact zone. Bedwyn Sands is an intertidal 'sand flat' straddling the boundary between English and Welsh territorial waters, whereas NMG (areas 455 and 459) is entirely within Welsh territorial waters (Figure 12-1).

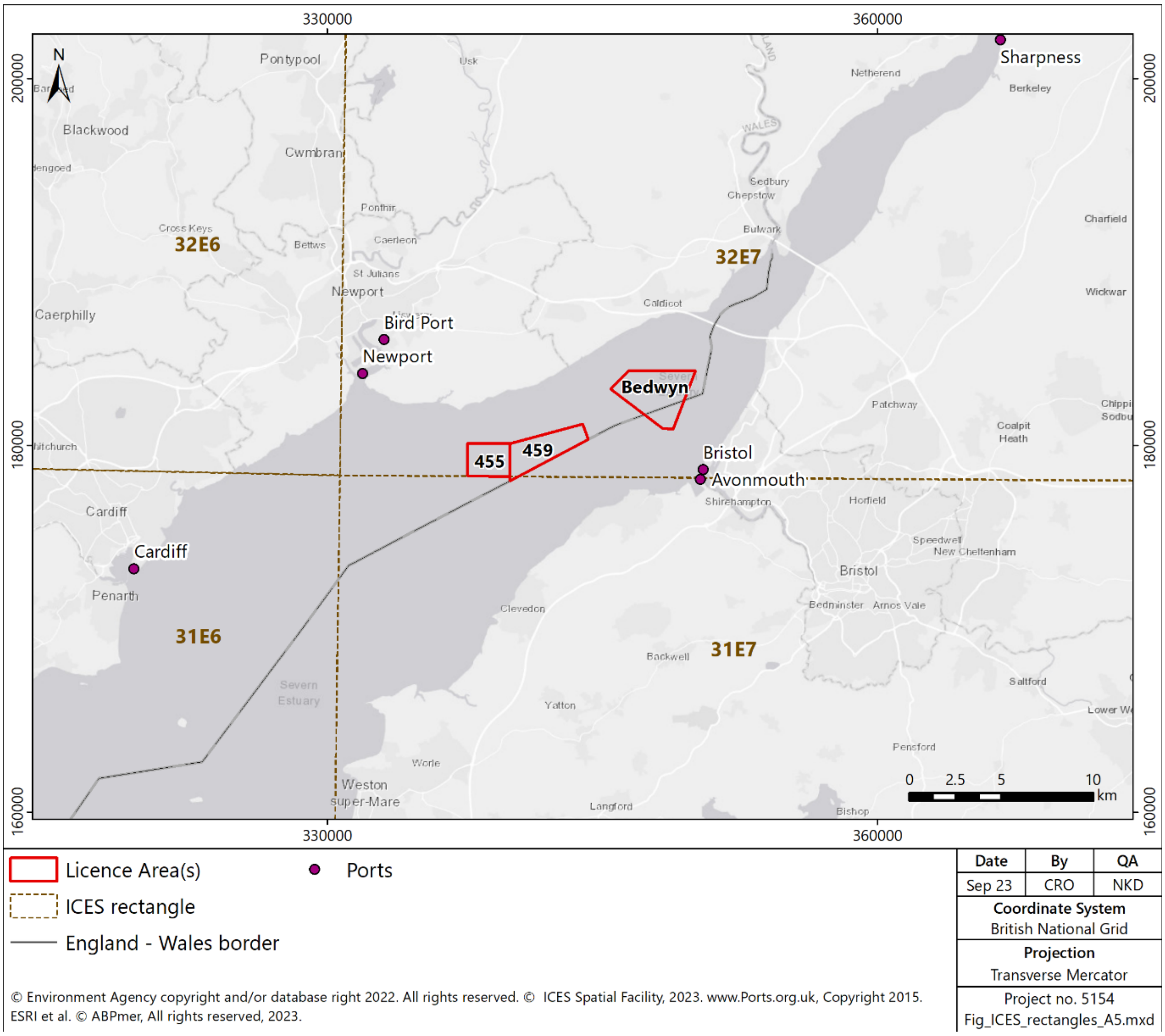


Figure 12-1 ICES rectangles and local ports in study area

12.1 Data sources and consultation

12.1.1 Data sources

A desk-based review of publicly available data and information has been undertaken to determine baseline fisheries features in the study area (ICES rectangles 31E7 and 32E7). It included: a review of recent fish landings, registered fishing vessels, and fishing activity sighting data; a review of Severn Estuary Shellfish and Sea Fisheries Byelaws; a review of any relevant fisheries management plans and/or reports; and consultation with stakeholders.

The principal data sources consulted during this assessment are as follows:

- Fisheries landings by UK vessels from ICES rectangles 31E7 and 32E7 from the Marine Management Organisation (MMO) 2016-2020;
- MMO/Welsh Government VMS/sightings data;
- UK fishing vessel registry (MMO, 2023);
- The UK National Inshore Fisheries Data Layer (NIFDL) covering 2007-2009;
- Wales Marine Planning Portal;
- Byelaws and other legislation governing shellfish and finfish fisheries in the Severn Estuary;
- Severn Estuary Partnership website;
- Devon and Severn Inshore Fisheries Conservation Authority website;
- Charter Boats UK website;
- Fishing in Wales website;
- Bedwyn Sands Environmental Statement (ABPmer, 2015);
- North Middle Ground Environmental Statement (ABPmer, 2016); and
- Area 531 Environmental Statement (ABPmer, 2019).

12.1.2 Consultation

Consultation, regarding the outcomes of the formal scoping process and whether there are any likely effects of the continued aggregate extraction, has been undertaken as appropriate, with various high-level stakeholders, including NRW and Welsh Government Marine and Fisheries Division (WGMFD), Devon and Severn IFCA (DSIFCA) Welsh Fisherman's Association (WFA) and North Devon Fishermen's Association. Charter fishing vessels who are based within the study area (i.e., ICES rectangles 31E7 and 32E7) were also contacted.

The consultation that has been undertaken, along with the outcome of such consultation and how it has influenced this assessment, is provided in Table 12-1. Further details are provided in Appendix A.

Table 12-1 Summary of consultation to date

Consultee	Reference, Date	Summary of Response	How Comments have Been Addressed in this Chapter
MMO	Scoping Opinion, 04 November, 2022	MMO supports the intention to consult with local fisheries stakeholders, including the Devon and Severn Inshore Fisheries and Conservation Authority (IFCA), and Welsh Fishermen's Association.	Noted. Such stakeholders were contacted via email

Consultee	Reference, Date	Summary of Response	How Comments have Been Addressed in this Chapter
NRW	Scoping Opinion, 04 November, 2022	No comments received in relation to commercial and recreational fisheries; however, please consider the relevant comments raised within the Nature Conservation chapter.	Noted, and comments have been taken into consideration, where relevant. Majority of comments have been addressed in the 'Benthic Habitat and Species' and 'Fish and Shellfish' chapters.
	Email, 11 July, 2023	Provided information on eel fisheries, heritage fisheries, and recreational fishing and angling within the study area.	Incorporated information into 'Review of baseline understanding' and impact assessments.
WGMFD	Email, 11 July, 2023	Offered to undertake data analysis of commercial fisheries in ICES rectangles 31E7 and 32E7. Provided details and heat map of all Welsh fishing vessel locations in ICES rectangle 32E7 during 2022-2023 (29.08.23 inclusive).	Incorporated information into 'Review of baseline understanding' and impact assessments.
WFA	Email, 11 July, 2023	No response to date	
DSIFCA	Email, 11 July, 2023	No response to date	
Charter fishing vessels (x4) – based in Portishead, Cardiff or Penarth	Email, 11 July, 2023	Three responses to date. Two charter vessels stated that the dredging does not detrimentally affect their fishing activities. One charter vessel commented that there have been changes to their fishing grounds within the vicinity of the dredge sites; however, they are unable to attribute such changes to dredging activities.	Incorporated information into 'Review of baseline understanding' and impact assessments.
North Devon Fishermen' Association (NDFA)	Email, 14 Aug 2023	A couple of NDFA fishing vessels do fish in the wider study area, however, they should be of no concern to dredging activities. One vessel owner commented that although they do not fish in the area, they are concerned that dredging is damaging the habitat and fish stocks.	Incorporated information into 'Review of baseline understanding' and impact assessments.

12.2 Review of baseline understanding

12.2.1 Regulatory framework

UK fisheries are governed under the UK Fisheries Act 2020, which consists of a framework for fisheries policy and management in the UK and sets out eight fisheries objectives which encompass the overall aims of the Act: sustainability; precautionary; ecosystem; scientific evidence; bycatch; equal access; national benefit; and climate change. Fisheries is predominantly a devolved matter, and therefore the four fisheries administrations have produced a Joint Fisheries Statement (JFS) (Defra *et al*., 2022), setting out how the objectives will be achieved.

Due to the cross-border nature of the Severn Estuary, responsibilities for fisheries management and legislation for this area encompasses both Welsh and English administrations. In July 2023, the MMO and Welsh Government jointly published 'The Severn Estuary: A cross-border marine planning guide', which provides an overview of marine planning policies and related considerations relevant to the Severn Estuary (Welsh Government and MMO (2023)).

English legislation

Management of inshore fisheries England, defined as those within the 6 nm limit, is primarily the responsibility of the IFCAs. The Devon and Severn IFCA (DSIFCA) district extends six nautical miles from both the north and south Devon coastlines and includes the English side of the Severn Estuary. Together with the MMO, they work to achieve sustainable fisheries management and marine conservation. IFCAs aim to 'lead, champion and manage a sustainable marine environment and inshore fisheries, by successfully securing the right balance between social, environmental and economic benefits to ensure healthy seas, sustainable fisheries and a viable industry' (Defra, 2011).

DSIFCA has implemented a number of local byelaws including:

- Mobile Fishing Permit Byelaw (Marine and Coastal Access Act 2009);
- Netting Permit Byelaw 2016 (Marine and Coastal Access Act 2009, c.23);
- Potting Permit Byelaw (Marine and Coastal Access Act 2009); and
- Diving Permit Byelaw (Marine and Coastal Access Act 2009).

The Environment Agency is responsible for managing freshwater fisheries and issuing relevant licences.

Restrictions have been placed on salmon and sea trout fishing in the River Severn and Severn Estuary in response to the decline in migratory stocks. The byelaws introduced by the Environment Agency in 2021 require all salmon and sea trout caught on rod and line to be released alive with minimum injury and delay, via new controls on angling methods (Environment Agency (2021)). Commercial net fisheries for Putcher ranks and Draft nets in the Severn Estuary have also been closed. However, lave nets will be allowed to continue 'catch and release' salmon for cultural purposes, but there is a limit of 22 lave net licences.

Eel fisheries in the study area are regulated via 'The Eels (England and Wales) Regulations 2009 and includes requirements for licences (issued by the Environment Agency) and their associated conditions.

In 2021, the MMO published the 'South West Inshore and South West Offshore Marine Plan' for England, which includes the Severn Estuary (and study area). The plan provides a framework that will shape and inform decisions over how the areas' waters are developed, protected, and improved over the next 20 years. Commercial fisheries and their sustainability are referenced in the plan.

Between the 6 nm and 12 nm limits, the MMO has primary responsibility for fisheries management under the guidance of Defra. However, for the purpose of this assessment, the study area of ICES rectangles 31E7 and 32E7 do not exceed the 6 nm inshore fisheries limit, and therefore fisheries management for this study is the responsibility of DSIFCA.

Welsh legislation

The Welsh Government (WG) develops central fisheries policies and is responsible for the implementation and enforcement of relevant UK and Welsh fisheries legislation and licencing. Responsibilities also include periodically reviewing secondary legislation to ensure it remains fit for purpose. The Welsh Ministers have also assumed responsibility for inshore marine fisheries following the abolition of the Welsh Sea Fisheries Committees on 1 April 2010. The South Wales Inshore Fishery Legislation was published in 2011 and includes byelaws relevant to the study area. Responsibility for the administration of freshwater fisheries in Wales is shared between WG and NRW.

The 2013 Strategic Action Plan for Wales Marine and Fisheries (Welsh Government, 2013) sets out a framework for achieving clean, healthy, safe, productive and biologically diverse seas. For fisheries, this sets out the aim to help build a sustainable industry in a way that does not compromise the future for a healthy and diverse marine environment.

The Welsh National Marine Plan (2019), in relation to fisheries, sets out an objective 'to support and safeguard a sustainable, diversified and profitable fishing sector including promoting sustainable capture fisheries and optimising the economic value of fish caught as a supply of sustainable protein'. The Plan recognises the diverse nature of the Welsh commercial sea fishing sector, which is predominantly made up of small (under 10 m length) vessels operating from dispersed coastal locations. The Plan also recognises the contribution the sector makes to many rural coastal communities, the cultural and heritage linkages, and importance of fish and shellfish to food security.

In February 2022, Welsh Government introduced legislation requiring all Welsh commercial fishing vessels to carry fully functioning iVMS trackers onboard. Via this legislation, it is also compulsory for any non-Welsh vessel vessels operating within the Welsh Zone to comply with this requirement. The reporting frequency of the iVMS is 10 minutes.

Within Wales, NRW implement Angling byelaws, which include closed seasons, method restrictions and/or 'catch and release' restrictions for salmon, sea trout and eels.

12.2.2 Regional overview

Commercial fisheries

Commercial fishing within the Severn Estuary is very limited, and within the study area (ICES rectangles 31E7 and 32E7), only three under-10 m vessels (Table 12-2) are registered at the sole port of Newport, Wales. No vessels over-10 m in length are registered. The small number of commercial vessels fishing this area is predominantly attributed to the large tidal range limiting the use of fishing gear (Emu, 2004; HR Wallingford, 2003). In addition, the Severn Estuary and the Inner Bristol Channel are important nursery areas for several fish species, resulting in the majority of fish present being juveniles. Limited commercial fishing activities are further corroborated by the UK National Inshore Fisheries Data Layer (2007-2009) produced by Cefas using fishing vessel sightings, which revealed no activity within the inner Severn Estuary. Despite this, small commercial fisheries for whitefish and shellfish do currently exist.

Table 12-2 Number and size class of fishing vessels registered within ICES rectangles 31E7 and 32E7 as of July 2023

Home Port	<10 m	>10 m
Newport	3	0
Bristol	0	0
Sharpness	0	0
Other Ports in 31E7 & 32E7	0	0

Source: UK vessel registry (MMO, 2023)

Recreational fisheries

Recreational fishing, taking place from both charter vessels and the shoreline, is common within the Severn Estuary. The Angling Trust report that, on a given day, there may be an estimated average of 200 anglers along the shoreline of the Inner Bristol Channel and Severn Estuary (ABPmer, 2019). Shore-based anglers target codling, flounder, and whiting during winter, and plaice, dogfish, and bass during summer. The most popular onshore angling sites of Minehead and Hinkley Point are outside of the study area (ICES rectangles 31E7 and 32E7); however, within the study area, Clevedon Pier, Portishead, Severn Beach, Sudbrook, Black rock, Caldicot pill, Sedbury, Chepstow and Newport, are known shore-based angling sites; but the number of anglers using these sites is unknown.

Charter fishing vessels are also active within the Severn Estuary. According to online searches, there are charter vessels based in Penarth, Wales; Cardiff, Wales; and Portishead, England; which are likely to fish in the study area. They are known to target a variety of species including cod, bass, smooth hound, conger eel, rays, flounders, whiting and rockling. Bedwyn Sands and NMG are areas fished by charter vessels for winter cod.

Fisheries for migratory species

In terms of migratory species, such as salmon, sea trout and eel/elver, there are no known fisheries within the study area. Historically, such fisheries were popular in the Severn Estuary, however, currently, salmon and sea trout fisheries are either closed or operating on a 'catch and release' basis. These mandatory regulations were implemented in response to declining fish stocks. Previously, the Severn Estuary also supported one of the largest eel fisheries in the UK, however, declining eel numbers over the past two decades have led to a significant reduction in eel fishing activities. NRW confirmed that they have not issued any permits for eel fisheries (*pers. comm.*). Furthermore, a recent report on estimating glass eel exploitation in the tidal reaches of the River Severn (Aprahamian and Wood, 2020), states that the main eel fishery is in the uppers reaches of the River Severn, between The Noose and Tewkesbury, which is outside of the study area, and is regulated by Natural England.

12.2.3 Commercial fishing activity at Bedwyn Sands and North Middle Ground

Bedwyn Sands and NMG are located within ICES rectangle 32E7 (Figure 12-1, however, to fully understand the fishing activities within Bedwyn Sands and NMG and their vicinities, fisheries data from ICES rectangles 31E7 and 32E7 have been considered. MMO landings data for these ICES rectangles (years 2016-2020) are summarised in Table 12-2 and Table 12-3. In summary, pots, hooks and nets are the fishing gear types used within the study area, and the average annual total catch value for the area is £569 GBP (Table 12-3). This highlights how minor commercial fishing activity is within the study area. Table 12-4 summarises the species groups fished within the study area. There are a variety of fished species, the landings of which vary from year to year. Furthermore, these tables illustrate that, between 2016-2020, pots and traps account for the greatest landed value (51%), followed by gears using hooks (36%) and drift and fixed nets (13%). In terms of species, the top three species landed by value were bass (41%), velvet crabs (25%) and lobsters (25%).

A limitation of this publicly available landings data is that not all landings or sales by under-10 m vessels are likely to be recorded for this time period (2016-2020) and therefore actual landings may be underrepresented. Additionally, vessel length is only categorised as '10 m and under' or 'over 10 m' and hence does not enable further breakdown of the data into more specific vessel length categories.

Table 12-3 Summary of landed value (£) for UK vessels by year, vessel length and gear type for ICES rectangles 31E7 and 32E7 combined for 2016-2020

Vessel length and Gear Type	Value (£)						
	2016	2017	2018	2019	2020	Grand Total	Mean (Year $^{-1}$)
10 m and under							
Pots and traps	-	-	-	271	1,174	1,445	**289**
Gears using hooks	443	43	209	107	217	1,018	**204**
Drift and fixed nets	217	103	64	-	-	384	**77**
Grand Total	**660**	**145**	**273**	**378**	**1,391**	**2,847**	**569**
No landing reported in the statistical dataset							

Source: MMO landings data 2016-2020

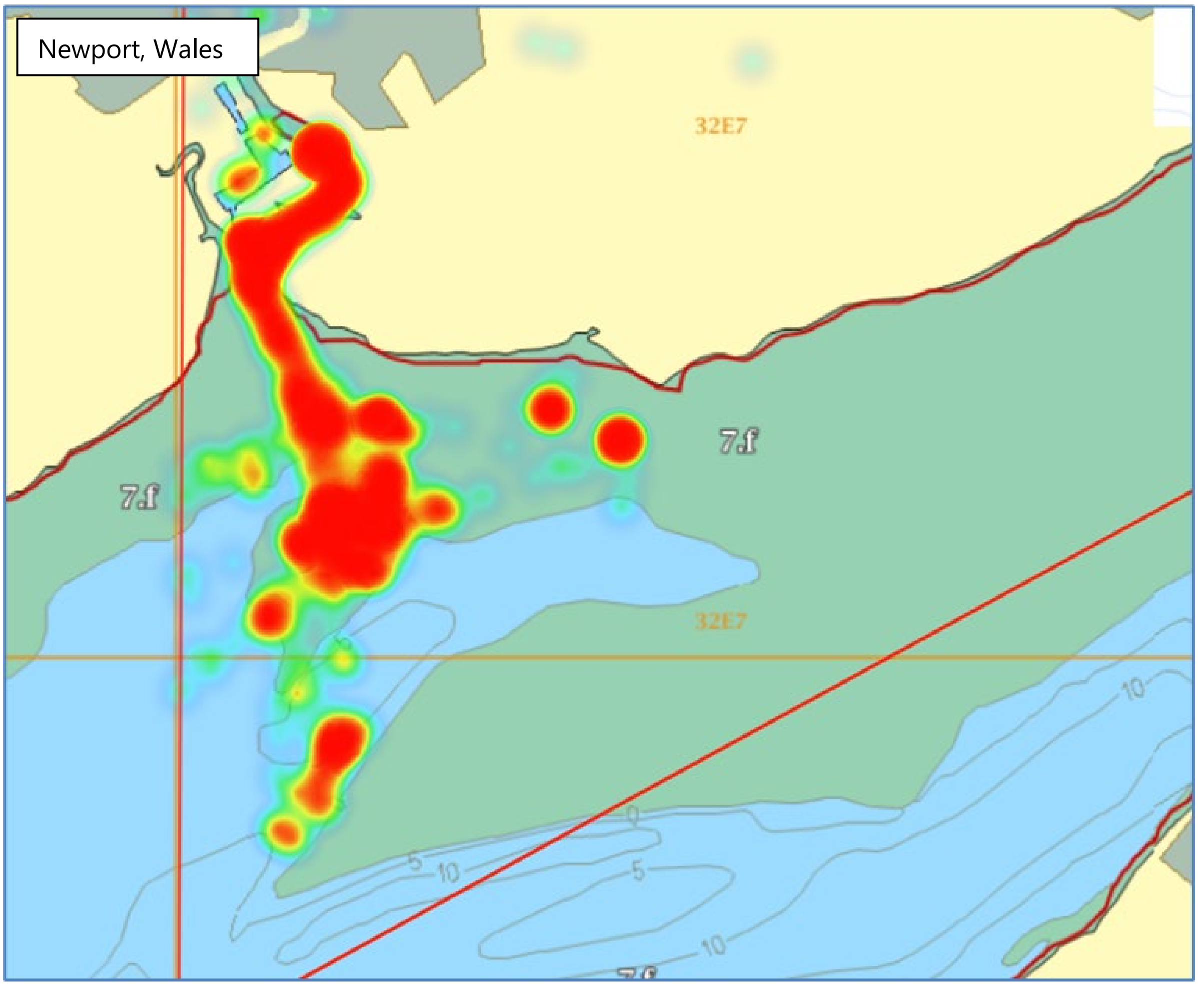
Table 12-4 Summary of species landing value (£) by gear type for UK vessels caught in ICES rectangles 31E7 and 32E7 combined for 2016-2020

Gear Type and Species Group	Value (£)						
	2016	2017	2018	2019	2020	Grand Total	Mean (Year $^{-1}$)
Bass							
Gears using hooks	443	43	209	107	210	1,011	202
Drift and fixed nets	154	-	-	-	-	154	31
Velvet Crabs							
Pots and traps	-	-	-	-	724	724	145
Lobsters							
Pots and traps	-	-	-	271	436	707	141
Mullet							
Drift and fixed nets	63	-	61	-	-	124	25
Sole							
Drift and fixed nets	-	67	-	-	-	67	13
Thornback Ray							
Drift and fixed nets	-	23	-	-	-	23	5
Cod							
Drift and fixed nets	-	13	3	-	-	16	3
Crabs							
Pots and traps	-	-	-	-	15	15	3
Pollack							
Gears using hooks	-	-	-	-	7	7	1
Grand Total	660	145	273	378	1,391	2,847	569

Source: MMO landings data 2016-2020

Currently, the three operational Welsh-registered fishing vessels are all considered to be netters, targeting bass, sole, flounder and skate/ray species (WGMFD, pers. comm). Figure 12-2 illustrates where Welsh commercial fishing vessels were operational within ICES rectangle 32E7 during 2022 and 2023 (to date). None of the fishing activity took place within Bedwyn Sands or NMG (Areas 455 and 459) dredge areas, which are located to the east of all the fishing activity.

Historically, there was more fishing activity out of Newport, Wales, but English bylaws which are now in place have resulted in a decline in commercial fishing within the study area (WGMFD, pers. comm).



Courtesy of WGMFD, 2023

Figure 12-2 Heat map illustrating Welsh commercial fishing vessel activity during 2022-2023 (29.08.23 inclusive) in the study area

12.3 Impact assessment

This section identifies the potential likely effects on fisheries receptors as a result of the continued aggregate dredging in Bedwyn Sands and NMG in the Severn Estuary. The aggregate dredging has the potential to affect fish and shellfish stocks through the following impact pathways:

- Disruption of fisheries activities due to dredger movements (Section 12.3.1); Damage to fishing gear (Section 12.3.2); and
- Indirect impacts on target fish and shellfish stocks (Section 12.3.3).

Impact pathways not included in the assessment: The impact of disturbance to benthic habitats, including impacts on critical habitats such as spawning, nursery and overwintering grounds, has not been assessed as it is addressed in Sections 8.3 (Benthic Habitats and Species) and Section 9.3 (Fish and Shellfish) Similarly, the impact of a sediment plume, including that beyond ICES rectangles 31E7 and 32E7, has not been assessed as it is addressed, if necessary, in Section 8.3 (Fish and Shellfish Ecology). Any impacts on water quality and physical processes have been addressed in Section 5.4 (Physical Processes) and 6.3 (Water and Sediment Quality). Thus, in summary, the following impacts and their effects have been scoped out of the current assessment of commercial and recreational fisheries:

- Noise and vibration;
- Bathymetric changes;
- Suspended sediment plumes;
- Contaminants;
- Waves;
- Tidal currents; and
- Sediment flux.

Cumulative impacts on fisheries could arise as a result of other coastal and marine developments and activities. These have been considered as necessary as part of the cumulative impacts and in-combination effects assessment included in Chapter 19 of this ES.

The following receptors have been considered as part of the assessment:

- Commercial fisheries that may operate within the Severn Estuary; and
- Recreational fishing (including both shore-based angling and charter fishing vessels).

12.3.1 Disruption of fishing activities due to dredger movements

Background

There could be potential disruption to fishing activities by:

- Interfering with fishing activities due to dredger movements obstructing navigational routes to fishing grounds; and
- Disrupting, obstructing or excluding fishing vessels (and fishing gear) from fishing grounds due to the presence (and movement) of dredgers.

The significance of the impact depends on the duration and timing of extraction activity, the level of fishing activity that exists within the immediate and wider area, and the scale and extent of any restrictions imposed on fishing.

Impact assessment - commercial fisheries

The aggregate dredging areas are located centrally within the Estuary; therefore dredgers will need to move to and from these areas before, during and after dredging activities. However, there are very few commercial fishing vessels operating within the inner Severn Estuary and study area. This has been confirmed via WGMFD data analysis (Figure 12-2) and consultation with Fishermen's Associations. Such vessels are <10 m in length and land limited catches (according to MMO landings data). Therefore, very few fishing vessels will be transiting, or fishing within or near, the aggregate extraction areas, and as such will have very limited interactions with dredgers. Furthermore, extraction typically comprises a small proportion of the licenced area. The extraction activities are also only temporary in nature.

Consideration is also given to the historic and ongoing dredging vessel movements that occur across the Renewal Areas.

The probability of occurrence is considered to be low and the magnitude of change to be small. This leads to negligible exposure to change. Given that the fisheries have some flexibility in where they fish in the estuary, the sensitivity of the feature is considered to be low; and this combined with the negligible exposure to change, results in 'no vulnerability'. The importance of these fisheries is considered to be low (because they are of very small scale), and together with lack of vulnerability, it can be determined that the potential impact to commercial fisheries in the study area due to dredger movement is **insignificant.**

Impact assessment - recreational fisheries

Shore-based recreational fishing in the Severn Estuary will not overlap with dredger movements to and from the aggregate dredging areas in the central estuary. Combining this with a low exposure rate due to the fact that the principal shore-based angling sites are not located in the study area, the potential impact to shore-based recreational fisheries by dredger movement is assessed as being **insignificant**.

Charter fishing vessels do frequent the study area, particularly in winter when fishing for cod, however, the vessels are few in number; and the consultation revealed that, in general, dredging does not detrimentally affect their fishing activities. Therefore, for charter fishing vessels, the probability of occurrence is considered to be low, and magnitude of change to be small, which leads to a negligible exposure to change. Given that the fisheries have some flexibility in where they fish in the Estuary, the sensitivity of the feature is considered to be low; as is the importance of these fisheries (because of the few charter vessels utilising the study area). The low sensitivity and negligible exposure to change results in 'no vulnerability' and, therefore, the potential impact to charter fishing vessels fisheries in the study area due to dredger movement is assessed as being **insignificant.**

12.3.2 Damage to fishing gear

Background

Damage to fishing gear could occur as a result of:

- Being damaged (or towed away) by a dredger.
- Bathymetric changes and snagging of fishing gear on newly created (or exposed) obstructions.

The significance of the impact to fishing gear is dependent on factors such as gear type and sediment type.

Impact assessment - commercial fisheries

Due to the minimal amount of commercial fishing taking place in the study area (including zero activity in the dredge areas of Bedwyn Sands and NMG), the probability of occurrence is considered to be low, and the magnitude of change to be small. This, therefore, results in a negligible exposure to change. Given that the fisheries have some flexibility in where they fish in the estuary, the sensitivity of the feature is considered to be low; and the importance of these fisheries is also considered to be low (because they are of very small scale). Furthermore, there are no known reports of fishing gear damage, and bathymetric changes, such as dredge depressions, are likely to be temporary and be infilled on the next tide. The low sensitivity and negligible exposure to change results in 'no vulnerability' and, therefore, the potential for damage to commercial fishing gear in the study area is assessed as being **insignificant**.

Impact assessment - recreational fisheries

Similar to the impact on commercial fisheries (due to minimal number of charter fishing vessels utilising the study area), and the lack of overlap between shore-based recreational fishing with dredging activities, the potential for damage to recreational fishing gear is considered to be **insignificant** (for both shore-based angling and charter fishing vessels)

12.3.3 Indirect impacts on target finfish and shellfish stocks.

Background

A change in the distribution and abundance of finfish and shellfish populations has the potential to result in indirect impacts on the commercial and recreational fishing sectors. Fishers rely on knowing where their target species reside at particular times of the year, hence any variation in species distribution and abundance could detrimentally affect fisheries catch rates. Such changes in species distribution and abundance could be a result of dredging activities.

Outputs from the fish and shellfish assessment (Section 9.3) indicate that the direct impacts on fish and shellfish species are minor (at worst).

Impact assessment -commercial fisheries

Given that the potential direct impacts on fish and shellfish species in the study area (Section 9) have been assessed as minor at worst, and that there is a very limited amount of commercial fishing taking place, the exposure to change is considered to be negligible to low (at worst). The fish and shellfish assessment also indicated that the majority of species are not overly sensitive to dredging, hence resulting in a ‘no vulnerability’ outcome, which when combined with the minimal commercial fishing activity, the commercial target finfish and shellfish stocks are not considered to be vulnerable. As described for the other impact pathways, the importance of the feature is considered to be low, therefore, the overall assessment is that the potential for indirect impacts on commercial target fish and shellfish stocks by dredging activities is considered to be **insignificant**.

Impact assessment - recreational fisheries

Similar to the impact on commercial fisheries, and the lack of overlap between shore-based recreational fishing with dredging activities, the potential for indirect impacts on target fish and shellfish stocks of recreational fishers by dredging activities is considered to be **insignificant.**

12.4 Summary and conclusions

Table 12-5 summarises the impact assessment judgements and conclusions; and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 12-5 Summary of potential impact, mitigation measures and residual impacts for commercial and recreational fisheries

Assessment	Summary
Exposure to change	Both commercial and recreational fisheries are exposed to a negligible exposure to change. This is primarily due to the very limited amount of fishing activity taking place in the study area, which has resulted in a low probably of occurrence and a low magnitude of change.
Estimation of vulnerability	Neither commercial nor recreational fisheries are considered to be vulnerable. This is primarily due to the very limited amount of fishing activity taking place in the study area (including the ability of fishing vessels to alter their fishing locations), and the low vulnerability of fish and shellfish species to dredging activities (see Section 9).
Estimation of significance	The impacts on commercial and recreational fisheries were assessed as being insignificant. This outcome was based on the fact that the estimation of vulnerability was considered to be 'none', and the importance of the feature considered to be low. The low importance of the feature was based on the fact that fishing activity takes place is on a very small scale within the study area, and that fishing vessels have some flexibility in where they are able to fish.
Conclusion	Overall, the impacts on commercial and recreational fisheries were assessed as being insignificant. This is principally due to the very small scale of the fisheries within the study area.
Confidence Assessment	This assessment is based on a range of data sources which provide a good understanding of the impact pathways. However, uncertainties are recognised, such as the sparse data on recreational fisheries. For commercial fisheries, consideration should be given to the dynamic and variable nature of the industry. There is a medium confidence in the assessment.

12.5 References

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13 Commercial and Recreational Navigation

This section assesses the effects of the proposed dredging in Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on commercial and recreational navigation receptors. Commercial navigation includes commercial shipping activity, military and government owned vessels and any other commercial marine operation such as fishing vessel navigation. Recreational navigation includes yachting, power boats and smaller marine craft not engaged in commercial activity.

This section commences with a presentation of the data sources and organisations/stakeholders consulted to inform the baseline and assessment (Section 13.1). The navigational baseline is reviewed in Section 13.2. The impact assessment is presented in Section 13.3 and conclusions are drawn in Section 13.4.

13.1 Data sources and consultation

13.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- Port statistics collected by the Department for Transport (DfT) and local ports;
- 1 yea of AIS data for the period of 01 June 2022 to the 31 May 2023 provided by VTExplorer;
- Royal Yachting Association's (RYA) national dataset of cruising routes, sailing areas, clubs and marinas;
- Marine Accident Investigation Branch (MAIB) accident to ships and personnel reports, 2013 to 2022 inclusive; and
- Royal National Lifeboat Institute (RNLI) complete dataset of all callouts from 2013 to 2022 inclusive.

13.1.2 Consultation

Stakeholder consultation regarding navigational safety was carried out with the following parties, summaries of the full responses are included in Table A-2 of Appendix A

- Gloucester Harbour Trustees – no concerns regarding vessels traveling through the Area as they are familiar with the current operations and no changes are proposed;
- The Bristol Port Company (TBPC) – no response;
- Associated British Ports (ABP) South Wales – dredging at these sites has no navigational impact for the ports of ABP ports of South Wales and have no comments of relevance in respect of the continuation of the licence; and
- Royal Yachting Association (RYA) – made note of the operations to dredge Bedwyn Sands and NMG and have no further comments to make.

13.2 Review of baseline understanding

For the purpose of this ES, the wider study area for the navigation assessment is proposed to cover Bedwyn Sands, NMG and the Severn Estuary, from a line between Cardiff and Western Super Mare up to a line directly east from Lydney across the River Severn.

The Bristol Channel and Severn Estuary is an important shipping area with large ships from national and international destinations using the Estuary's ports and anchorages. The study area includes a number of significant commercial ports, namely Bristol (Avonmouth and Royal Portbury Dock), Newport and Cardiff. Collectively, these ports are an important part of the regional and national economy; in 2022, they handled approximately 12 million tonnes of cargo representing around 2.7 % of the UK total (Department for Transport (DfT), 2023).

Commercial vessels enter the Severn Estuary from the south-west via the deep-water approaches in the Outer Bristol Channel. Those bound for Cardiff navigate to the north-west of Flat Holm whilst those transiting to Newport, Bristol or locations up-estuary of the Severn Bridge crossings take the deep-water channel between Flat Holm and Steep Holm. Vessels bound for Newport usually transit north of Flat Holm and south of Monkstone, and then transit towards the Newport Channel. Vessels bound for Bristol and Sharpness navigate through the Bristol Deep and King Road channels, with vessels continuing to Sharpness on the tidal River Severn (Severn Tidal Partnership, 2010). The Bristol Deep channel runs along the southern margins of Bedwyn Sands and NMG (see Figure 13-1).

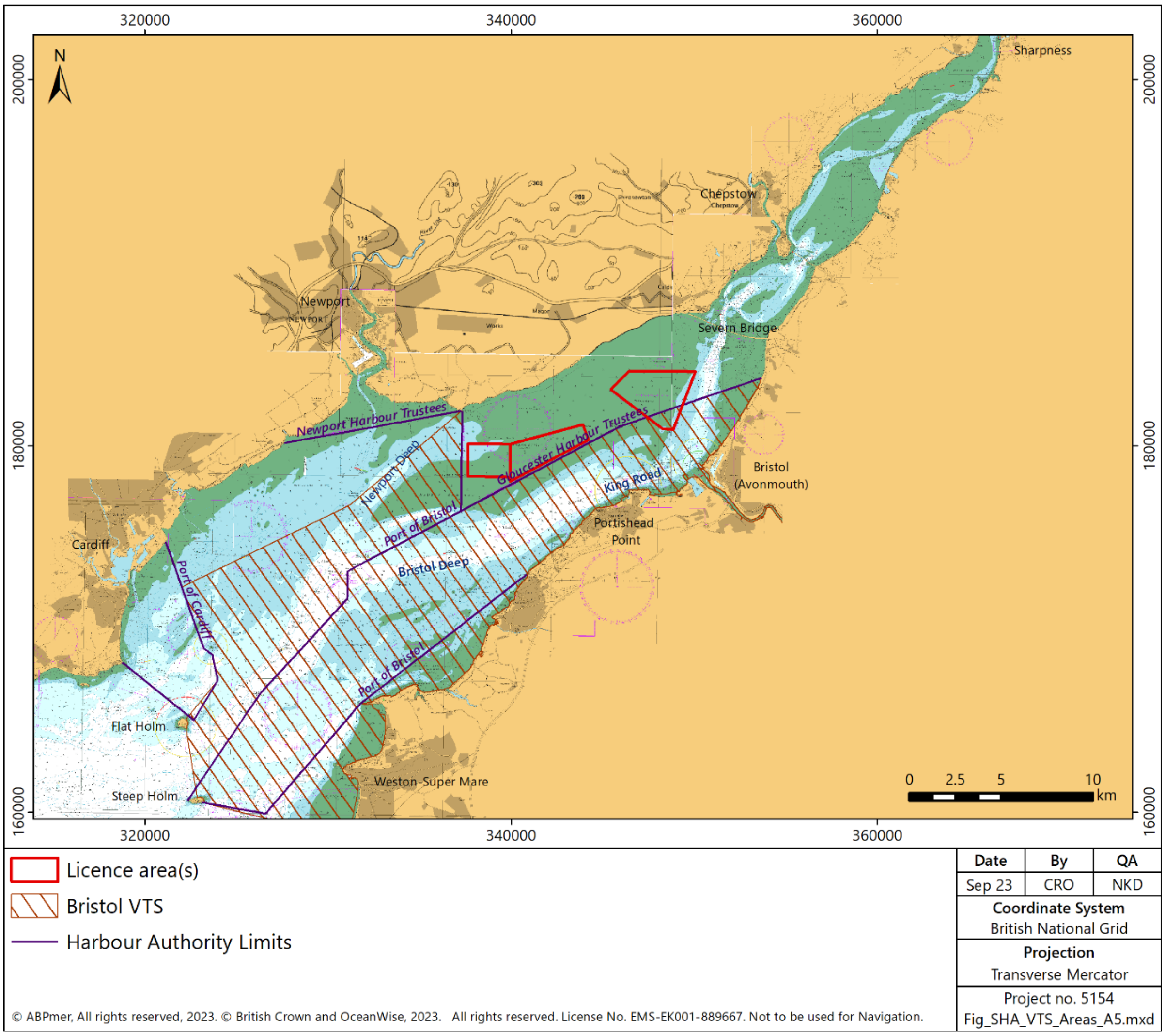


Figure 13-1 Statutory harbour limits in study area

A range of recreational boating activities take place in the wider study area, including keel boat racing/cruising, motor boating and dinghy sailing. Many of these activities are carried out through Royal Yachting Association (RYA) affiliated training centres and yacht/sailing clubs, of which there are several located in the wider study area. These include Newport and Uskmouth Sailing Club, Clevedon Sailing Club, Cardiff Yacht Club, Cardiff Bay Yacht Club, Penarth Yacht Club and Portishead Yachting and Sailing Club. Large marinas within the wider study area include Bristol (450 berths), Cardiff (350) and Portishead (250 berths).

13.2.1 AIS data in the wider study area

Figure 13-2 provides an overview of all vessel transits within the study area; Figure 13-3 to Figure 13-13 present a breakdown of these vessels into classes by type. The vessel types have been taken from AIS classifications inherent within the AIS signal. Figure 13-14 shows the average weekly vessel transit density in study area. The data represent one year of AIS data collected from 01 June 2022 to 31 May in 2023.

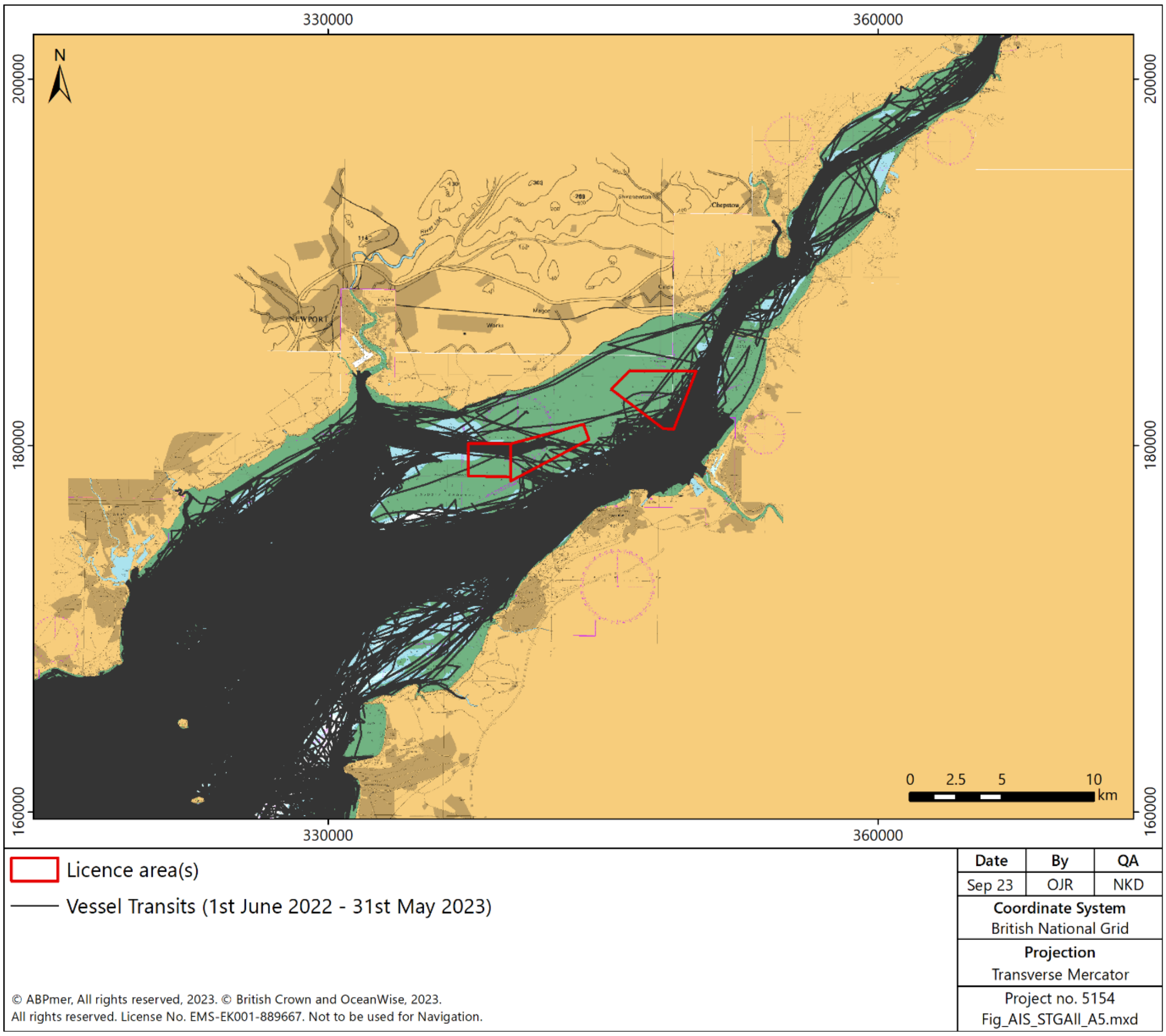


Figure 13-2 AIS all vessel transits in study area

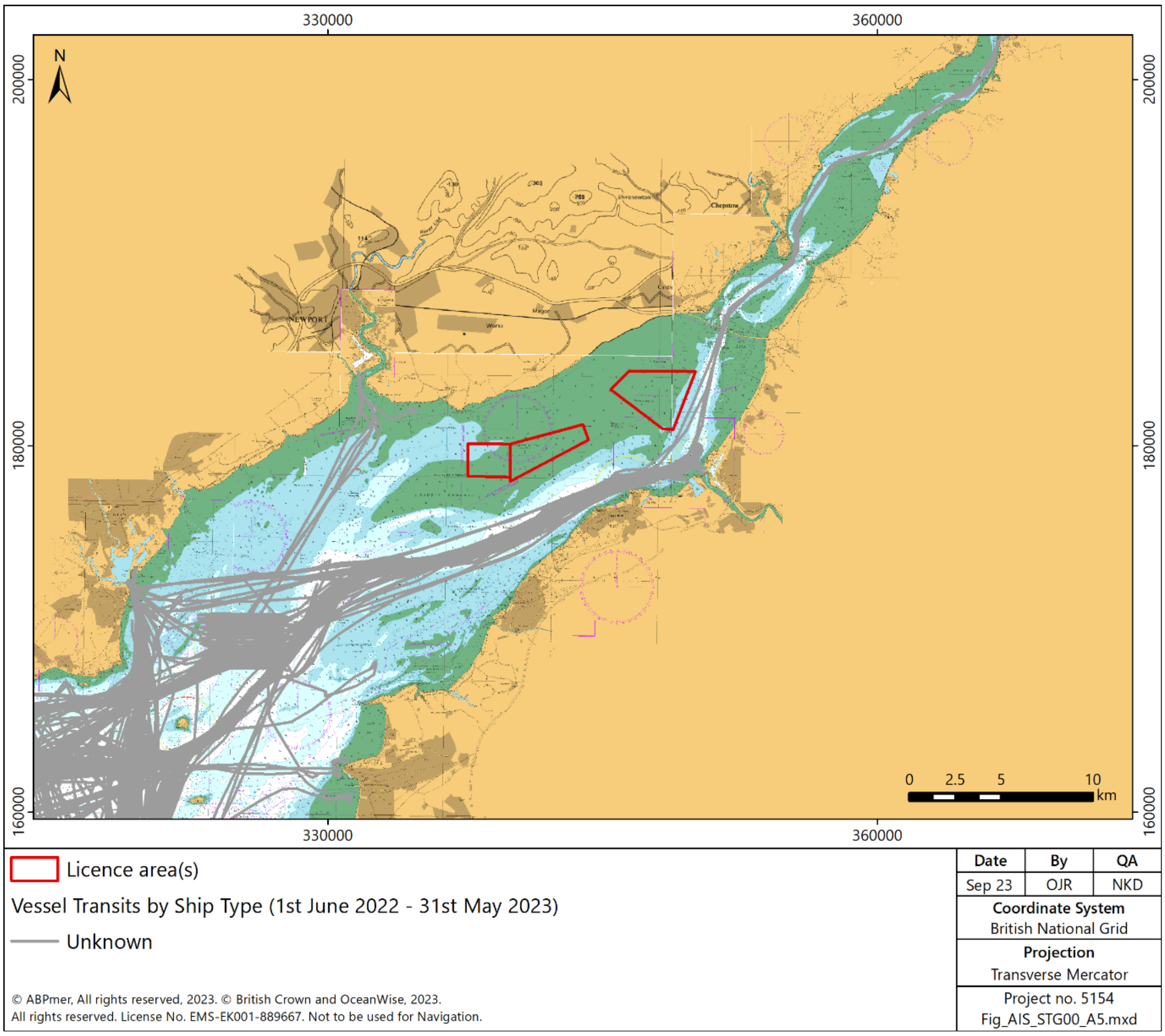


Figure 13-3 'Unknown' AIS transits in study area

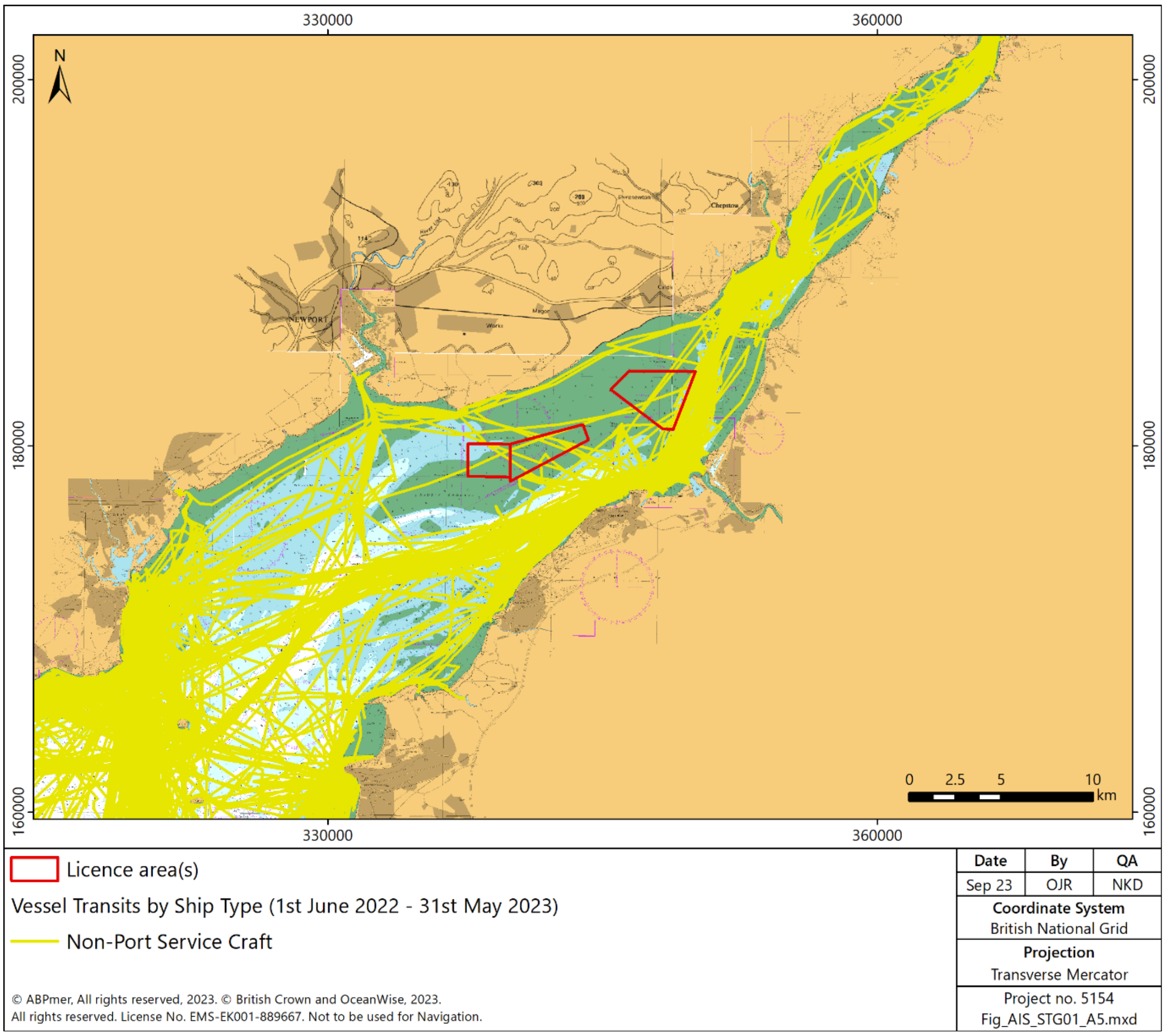


Figure 13-4 'Non-Port Service Craft' AIS transits in study area

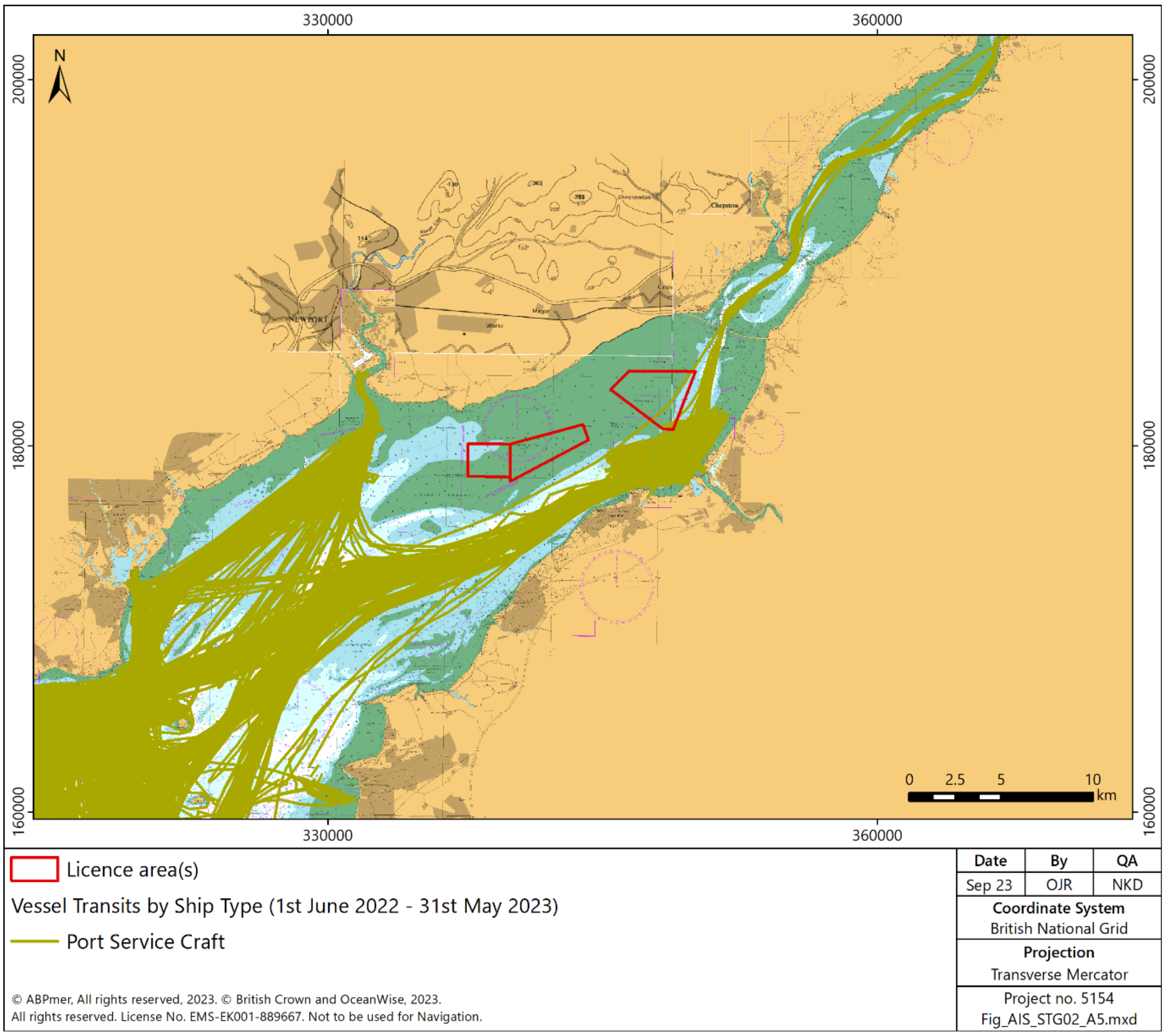


Figure 13-5 'Port Service Craft' AIS transits in study area

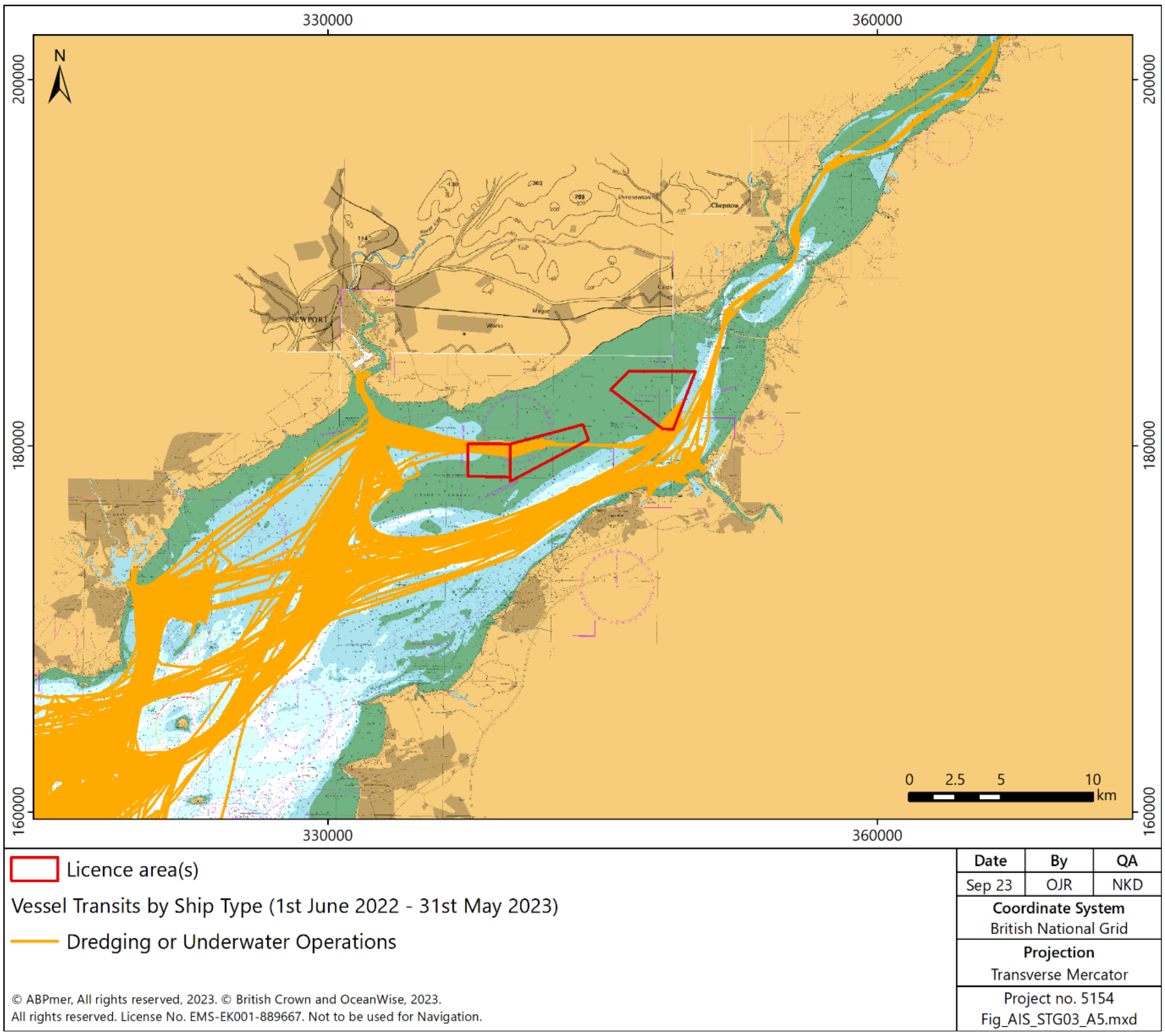


Figure 13-6 'Dredging or Underwater Operations' AIS transits in study area

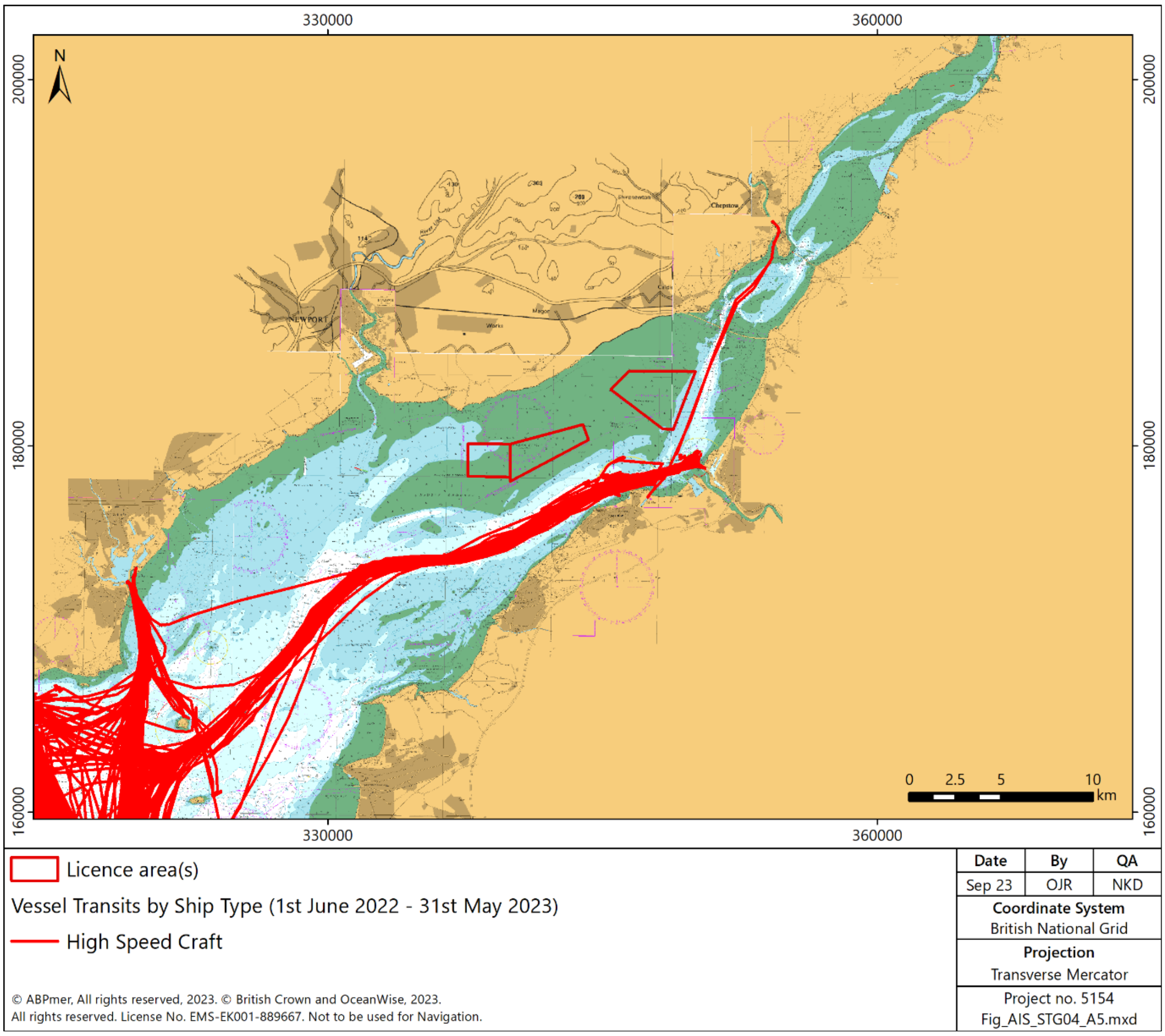


Figure 13-7 'High Speed Craft' AIS transits in study area

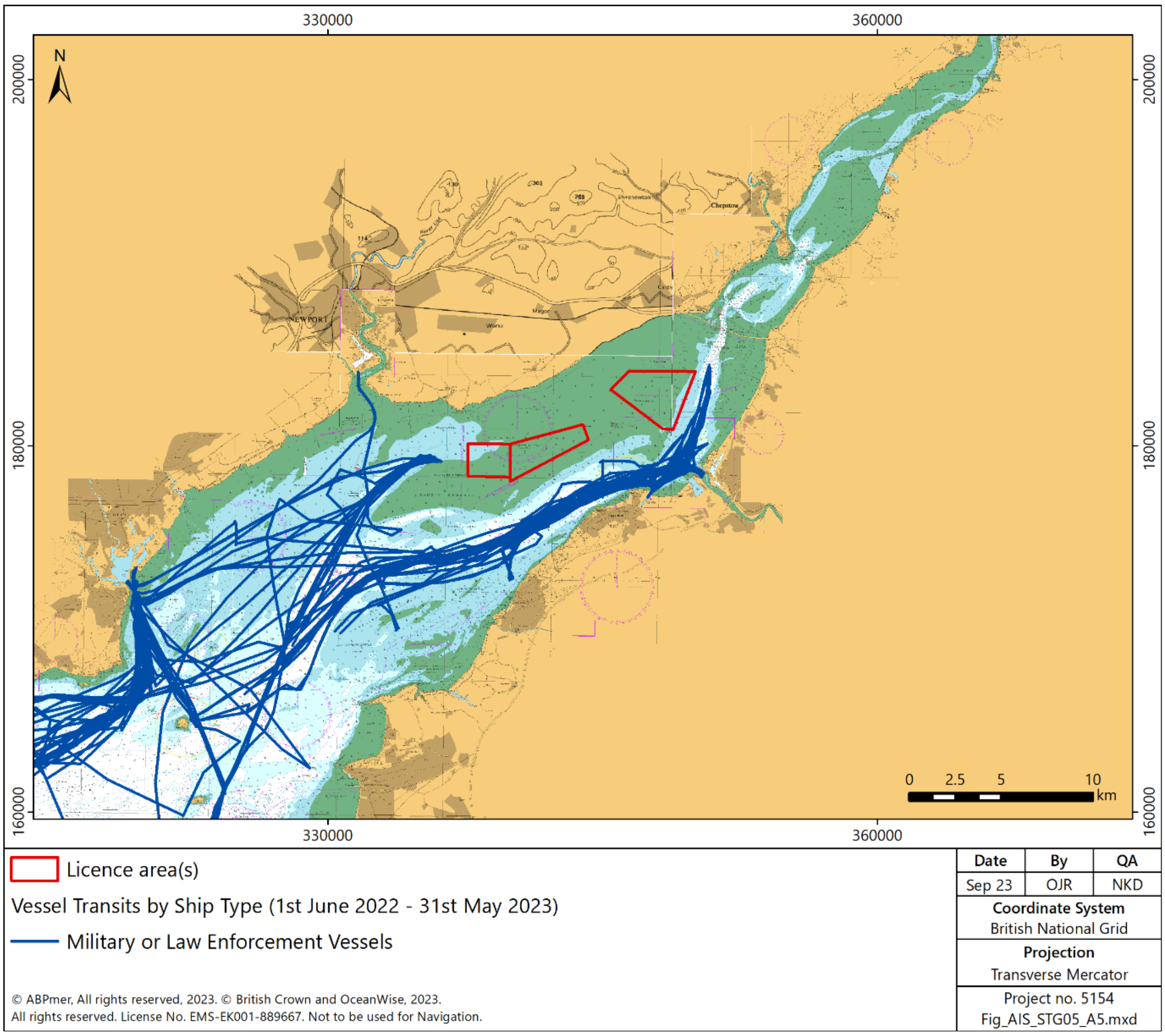


Figure 13-8 ‘Military or Law Enforcement Vessels’ AIS transits in study area

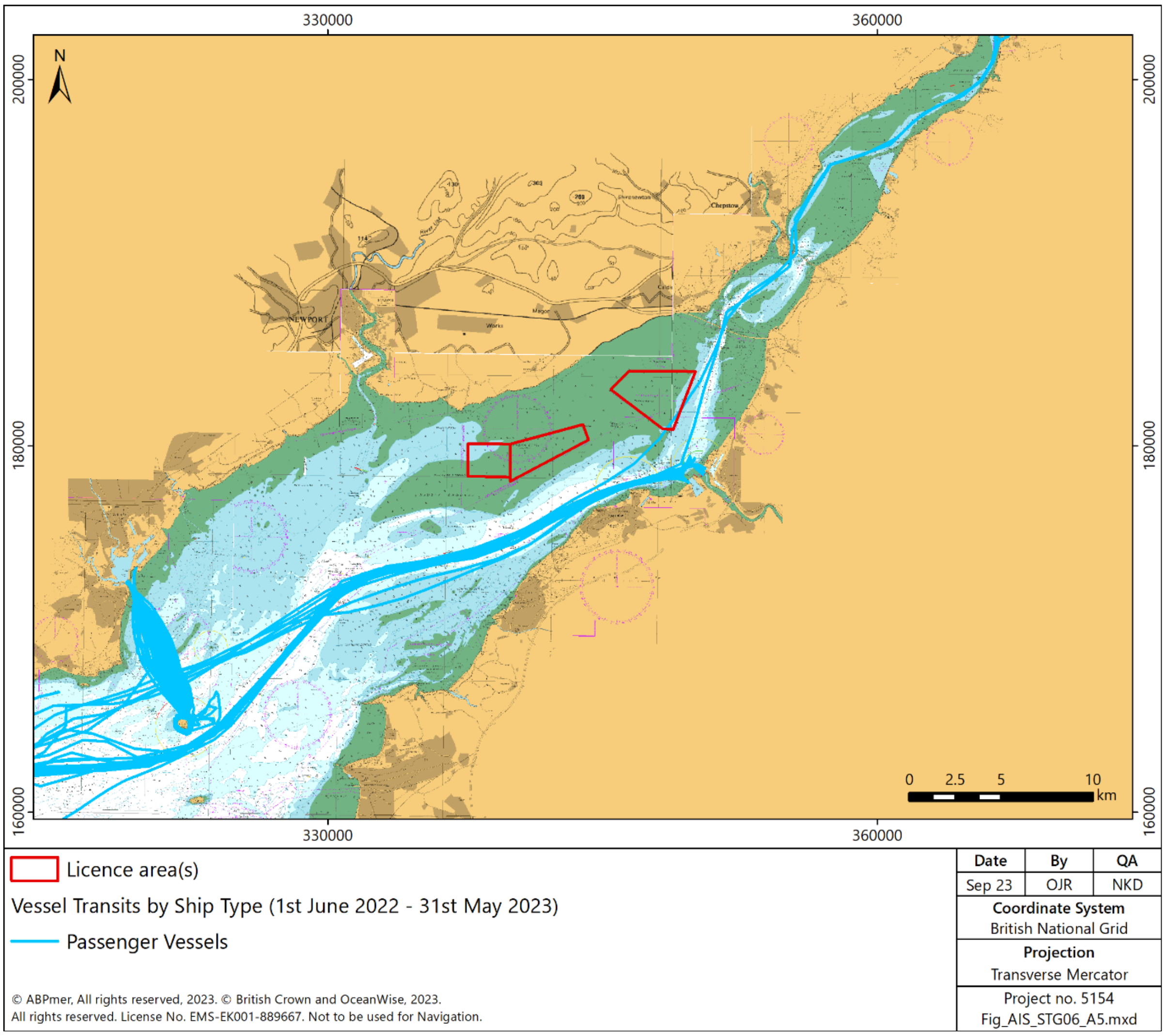


Figure 13-9 'Passenger Vessels' AIS transits in study area

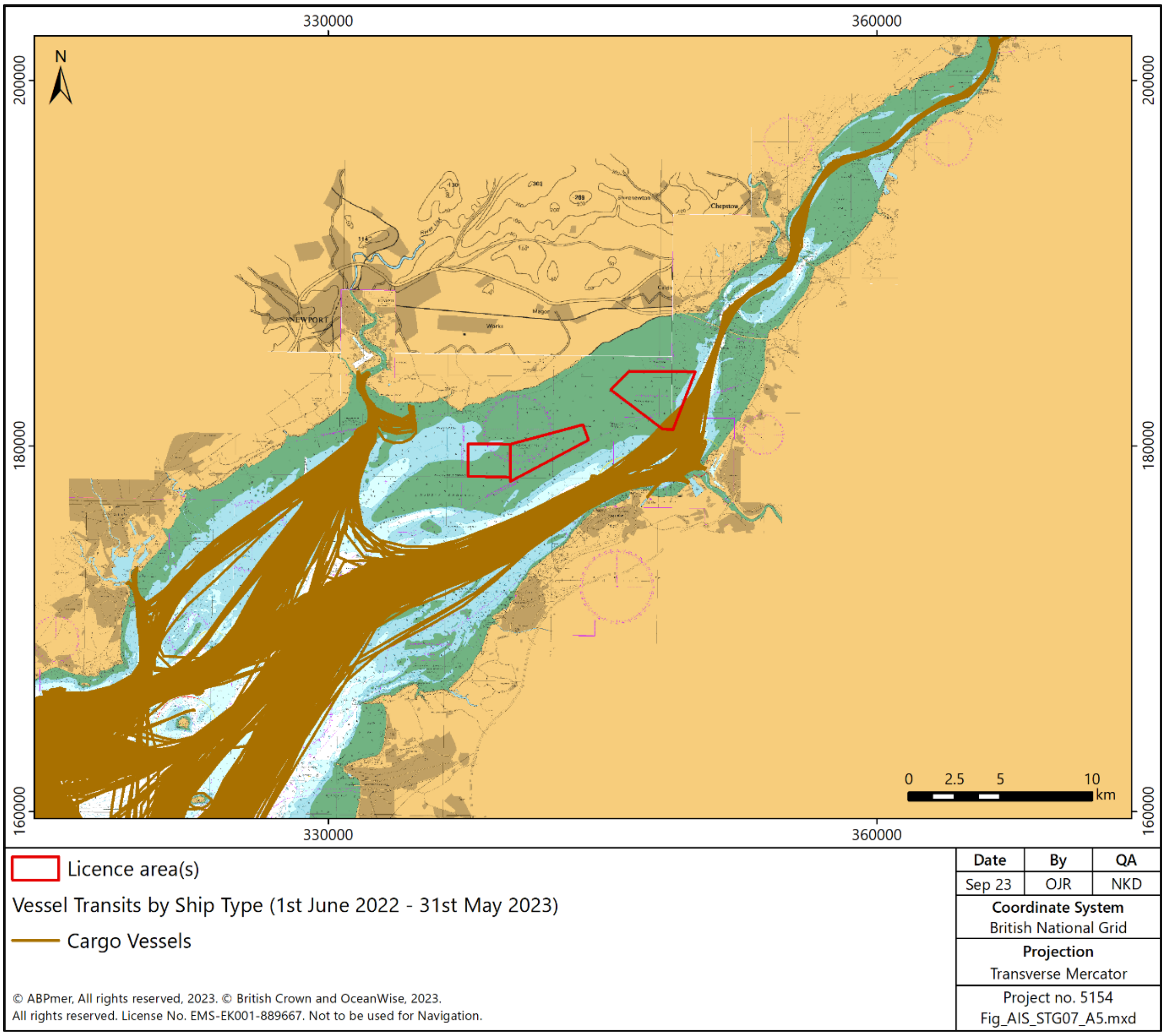


Figure 13-10 'Cargo Vessels' AIS transits in study area

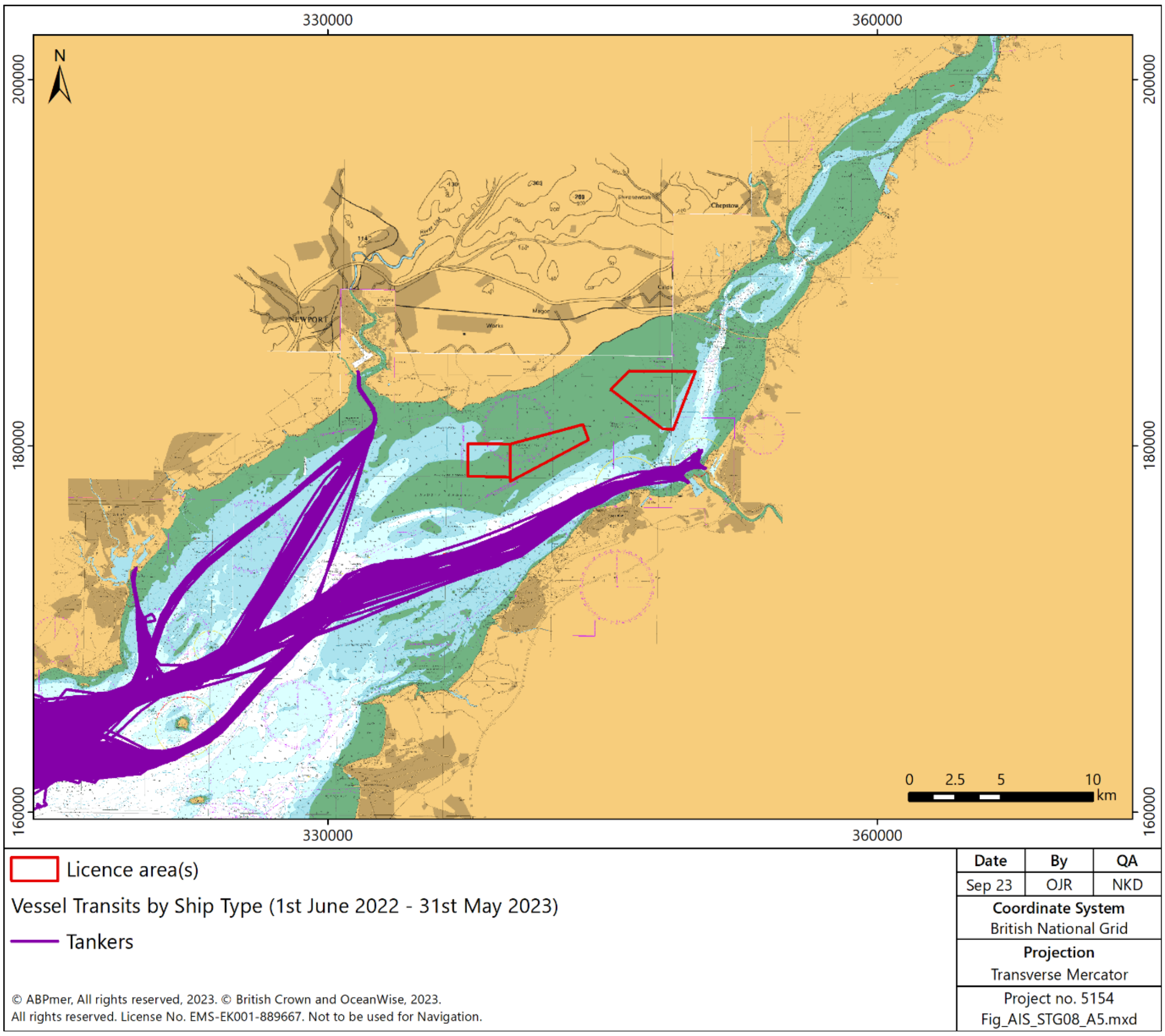


Figure 13-11 'Tankers' AIS transits in study area

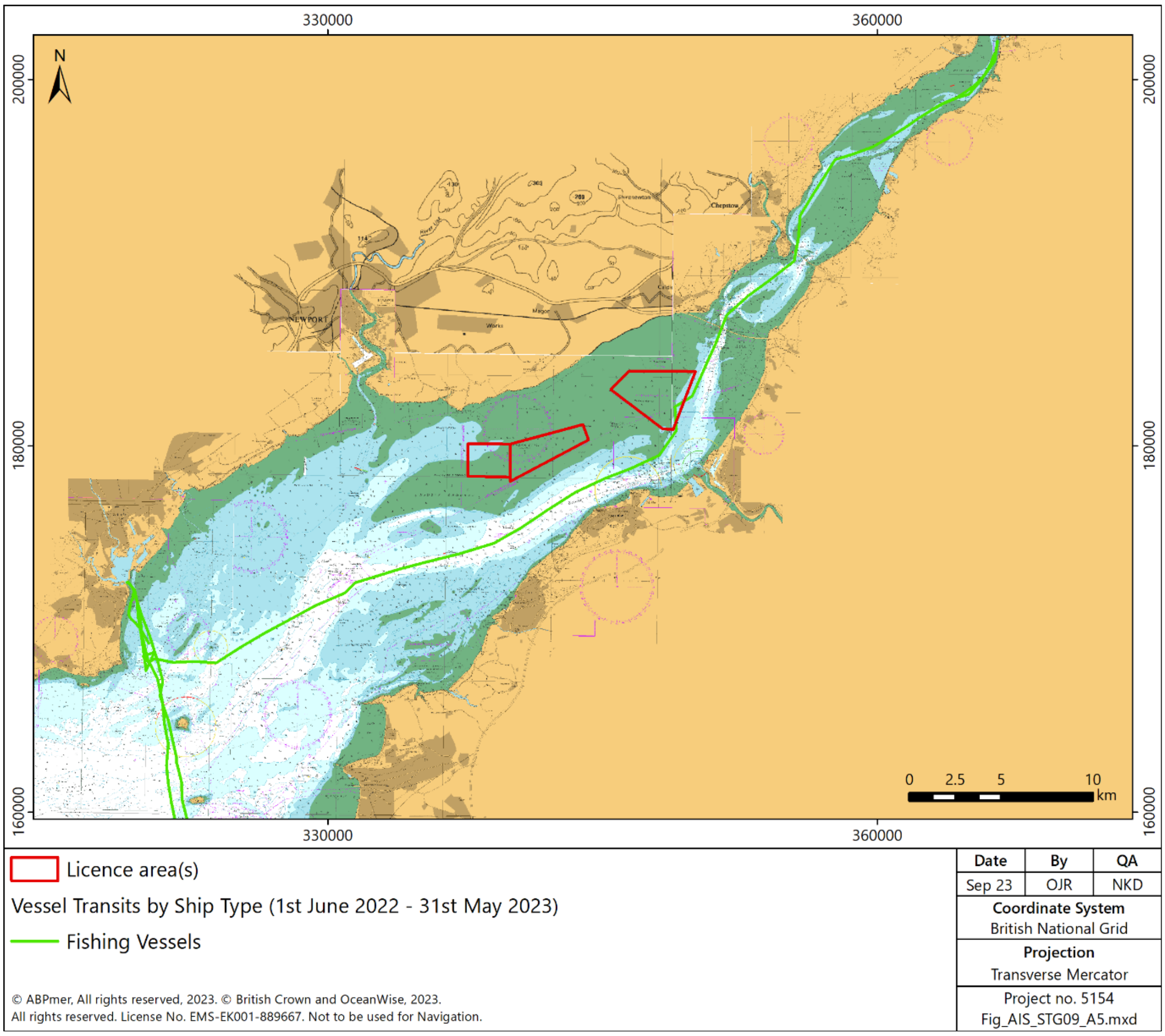


Figure 13-12 'Fishing Vessels' AIS transits in study area

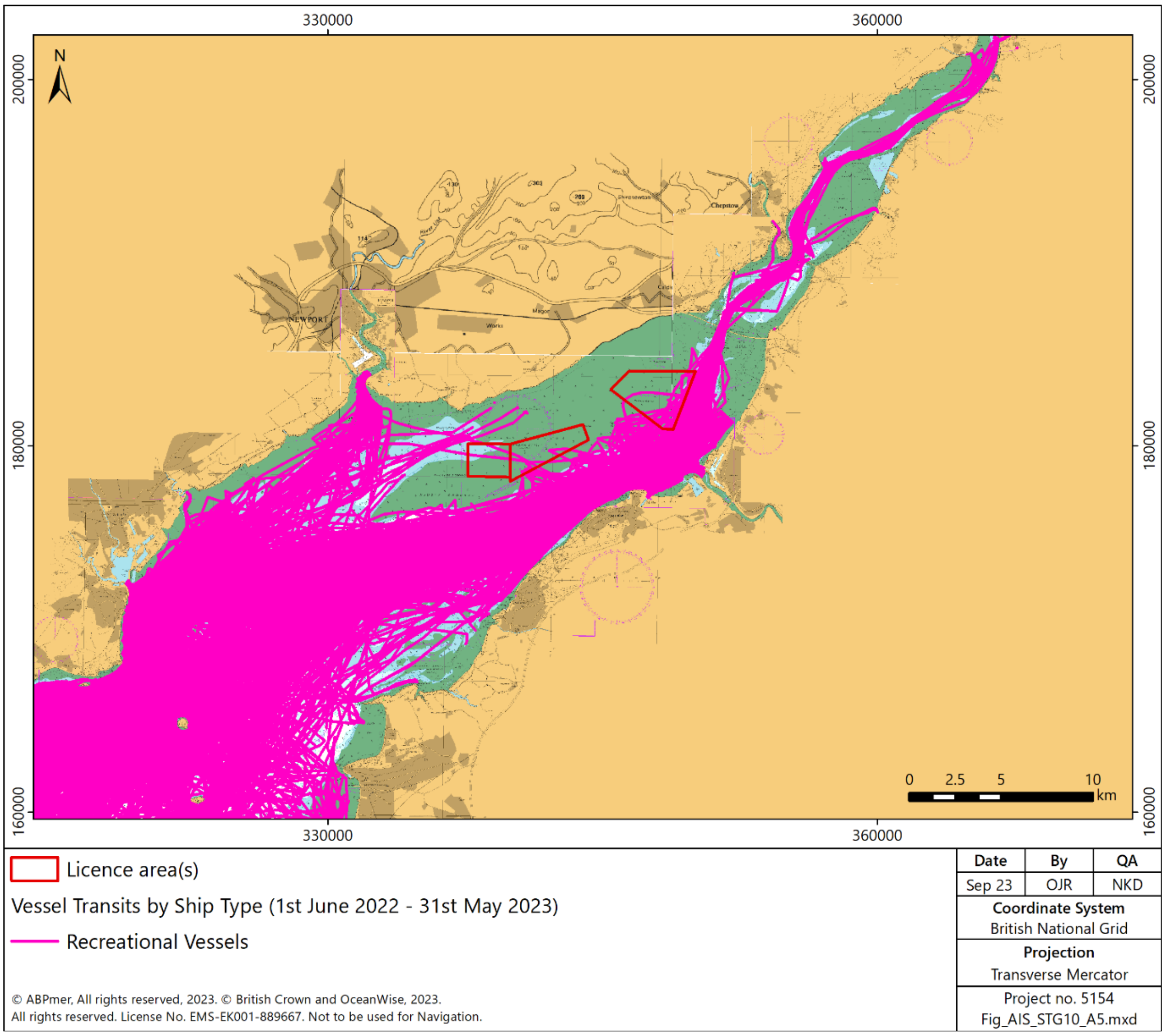


Figure 13-13 'Recreational Vessels' AIS transits in study area

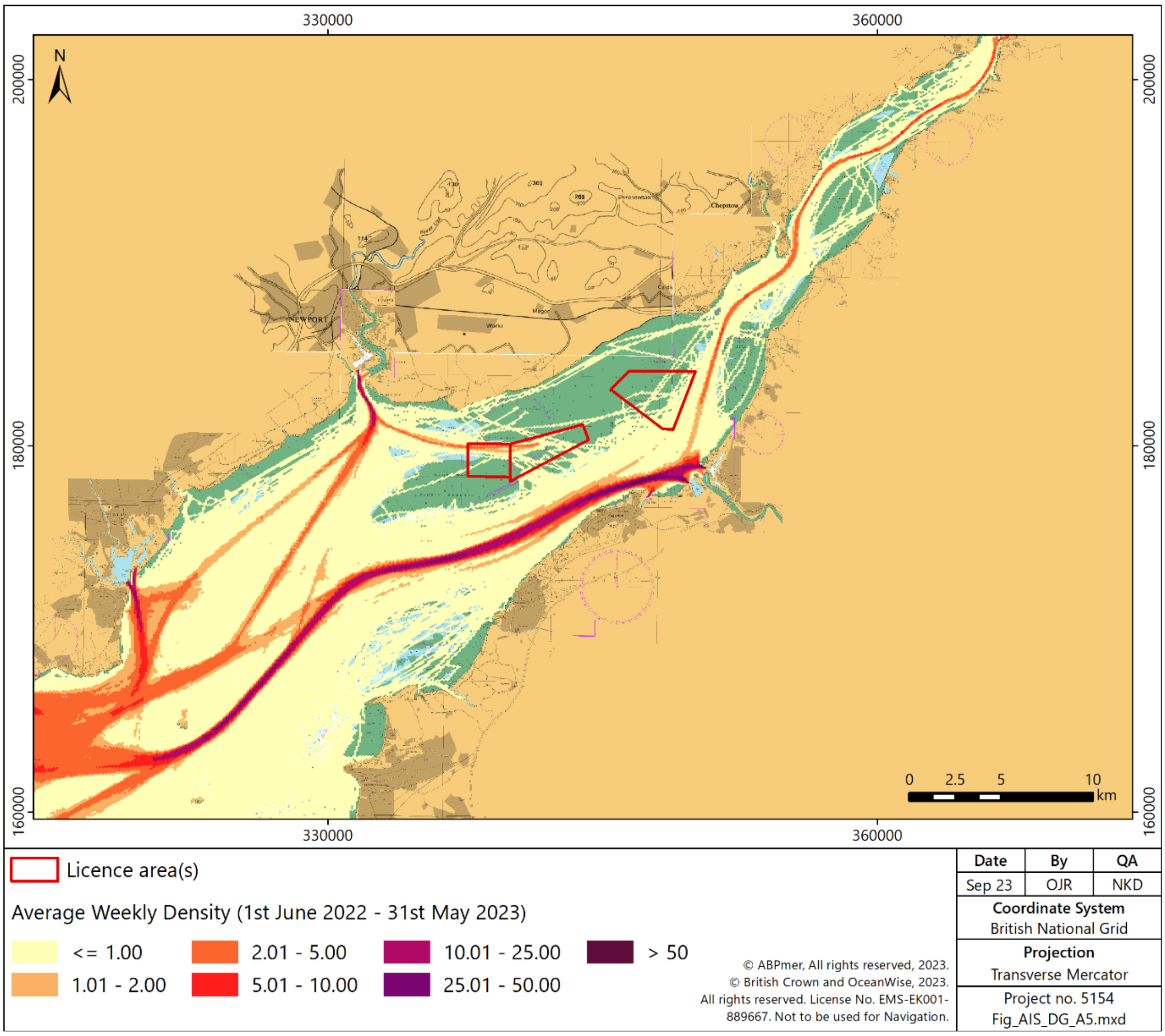


Figure 13-14 Average weekly vessel AIS transit density in study area

AIS signals are broadly classified as 'Class A' and 'Class B', where AIS-A is carried by international voyaging ships with gross tonnage (GT) of 300 or more tonnes, and all passenger ships regardless of size. AIS-B is carried by smaller vessels and is aimed at smaller commercial vessels, the fishing sector and recreational vessel users; however, the use of AIS-B is non-compulsory. Both AIS-A and AIS-B data have been used within this study. The AIS data has been broken down using the following vessel categories which are taken directly from the AIS data transmissions:

- Non-Port service craft;
- Port service craft;
- Dredging or underwater operations;
- High Speed Craft;
- Military or law enforcement vessels;
- Passenger vessels;
- Cargo vessels;
- Tankers;
- Fishing;
- Recreational; and
- Unknown.

Table 13-1 provides a summary count of the AIS transit data, of yearly activity. The table provides a measure of all the vessel transits within the study area. This information is provided spatially in Figure 13-3 to Figure 13-13. Each of these figures also identifies the location of Bedwyn Sands and NMG with vessel traffic overlaid.

Table 13-1 Vessel transits by ship type group in the wider study area

Vessel Category	Annual Transit Count	Transit Count Percentage
Cargo	3,751	25%
Fishing vessels	5	0%
High Speed Craft	218	1%
Military or Law enforcement	77	1%
Non-Port service craft	1,299	9%
Passenger	129	1%
Port service craft	4,810	32%
Recreational vessels	2,309	16%
Tankers	441	3%
Unknown Vessels*	296	2%
Vessels engaged in dredging or underwater operations	1,550	10%
Recreational	3,751	25%
Grand Total	**14,885**	**100%**

- Vessel type ‘unknown’ is an AIS record which was not correctly transmitting its vessel type and is included in the dataset to ensure full representation of known vessel activity.

Data Source: VTExplorer 2023

Table 13-1 shows that the largest proportion of vessels transiting the wider study area are Port service craft, with 32%. This vessel type includes tugs, pilot boats and port works craft moving between large vessels entering and leaving the region’s ports, moving between ports in the wider study area and providing maintenance tasks to buoys and port infrastructure. The next most common types of vessels navigating in the wider study area are Recreational and Cargo vessels with 16% and 25% total vessel transits respectively. The Recreational category includes craft such as sailing yachts and power boats which are used for leisure. The Cargo vessel category includes a mixture of different cargo types, such as Roll-on, Roll-off (RoRo), container, liquid and dry bulk cargoes.

13.2.2 AIS Data in NMG (Area 455 and 459)

Table 13-2 presents the AIS transits passing through NMG. This is presented as the count of vessel transits over a year period and a percentage for each ship type.

Table 13-2 Vessel transits by ship type group transiting NMG

Vessel Category	Annual Transit Count	Transit Count Percentage
Non-Port service craft	7	3%
Recreational vessels	12	5%
Vessels engaged in dredging or underwater operations	200	92%
Grand Total	**219**	**100%**

* Vessel type ‘unknown’ is an AIS record which was not correctly transmitting its vessel type and is included in the dataset to ensure full representation of known vessel activity.

Data Source: VTExplorer, 2023.

Figure 13-6 and Table 13-2 identify that the majority of vessels transiting through NMG are dredgers; this vessel type makes up 91% of traffic with transits in NMG. These dredgers are involved in the aggregates industry and are transiting from their home port, working the existing Licence Areas, and returning to discharge cargo.

Figure 13-4 and Figure 13-13 also identifies that there are a small number of Recreational crafts and Non-Port Service craft transiting through NMG; generally Recreational craft are transiting across the Welsh Grounds between Newport and Portishead. The Non-Port Service craft seen transiting through NMG, are transiting between the commercial ports of Newport, Bristol, Avonmouth and up-estuary of the M4 bridge. The port craft transiting through NMG are typically tugs and pilot boats, with a value of 3%.

As shown in Figure 13-2, NMG has a relatively low number of vessel transits. NMG has occasional vessel transits but is not heavily used by 'through traffic' given its location and available depth. The traffic density to the south of NMG is greatly increased along the deep-water route to Bristol and up-estuary of the Severn bridge crossings.

13.2.3 Bedwyn Sands area

Table 13-3 presents the AIS transits passing through the Bedwyn Sands Area. This is presented as the count of vessel transits over a year period and a percentage for each ship type.

Table 13-3 Vessel transits by ship type group transiting the Bedwyn Sands Area

Vessel Category	Annual Transit Count	Transit Count Percentage
Cargo	46	34%
Fishing vessels	1	1%
Non-Port service craft	9	7%
Passenger	1	1%
Port service craft	3	2%
Recreational vessels	33	24%
Vessels engaged in dredging or underwater operations	42	31%
Grand Total	**135**	**100%**
* Vessel type 'unknown' is an AIS record which was not correctly transmitting its vessel type and is included in the dataset to ensure full representation of known vessel activity.		

Data Source: VTExplorer, 2023.

Figure 13-10 and Table 13-3 identify that the majority of vessels transiting through Bedwyn Sands Area are Cargo vessels with 34% of traffic. These vessel types are seen transiting upriver from the deep-water channel to up-estuary of the M4 bridge and are transiting through the south-east portion of the of the dredge area. The second most common vessel type is dredgers; this vessel type makes up 31% of traffic with transits in Bedwyn Sands Area. These dredgers are involved in the aggregates industry and are transiting from their home port, working the existing Licence Areas, and returning to discharge cargo.

Figure 13-7 and Figure 13-13 also identifies that there are a number of Recreational crafts transiting through Bedwyn Sands Area; generally recreational craft are transiting between from Avonmouth and Cardiff to upriver beyond the M4 bridge. The Recreational vessels can also be seen transiting in the south-east portion of the proposed dredge area.

As shown in Figure 13-2, Bedwyn Sands Area has a relatively low number of vessel transits. The northerly section of Bedwyn Sands Area has little to no vessel transits and the southern section of this area is not heavily used by 'through traffic' given its location and available depth. The traffic density to the south of Bedwyn Sands Area is greatly increased along the deep-water route from Bristol and other commercial ports to up-estuary of the Severn bridge. The southernmost portion of Bedwyn Sands Area lies adjacent to this deep-water route.

13.2.4 Overview of harbour authorities

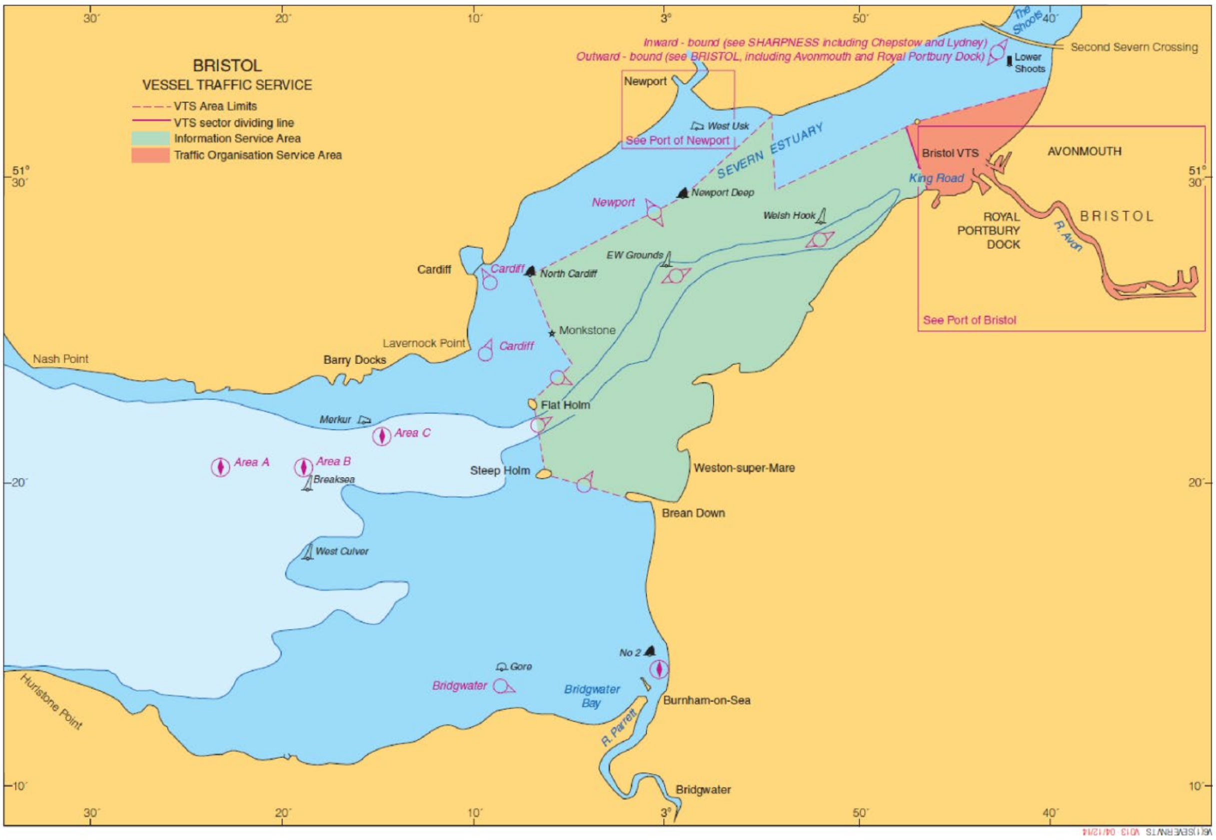
The wider study area has four Statutory Harbour Authority (SHA) areas. Each SHA has a range of duties, roles and responsibilities within their jurisdictional area; typically, this includes marine safety, managing marine traffic, aids to navigation, moorings, anchorage areas and maintaining channel depth. In addition, some harbour authorities also have Competent Harbour Authority status which relates to the provision of pilotage services.

The following provides a summary of the SHAs in the wider study area; the boundaries of which are shown on Figure 13-1:

- The Bristol Port Company (TBPC) is the Authority for the eastern side of the Severn Estuary from Avonmouth to the island of Steep Holm and up the tidal River Avon to Bristol. The Bedwyn Sands Area is partly located within the SHA area of TBPC, see Figure 13-1.
- Gloucester Harbour Trustees is the Statutory and Competent Harbour Authority for the tidal River Severn downstream of the weirs at Maisemore to Goldcliff, up to and including the Welsh Grounds, all dredge areas are within the limits of Gloucester Harbour Trustees.
- ABP is the Statutory Harbour Authority for the ports of Newport and Cardiff.
- Newport Harbour Commissioners is the Statutory and the Competent Harbour Authority for Newport Harbour. The main duties and responsibilities of the Commissioners are the provision and maintenance of navigation aids and generally to ensure the safety of navigation within Newport Harbour. They are also responsible for the provision of Pilotage, currently under a joint arrangement with ABP. Since 1 February 2005, ABP have carried out the functions of Harbour Master (NHC, 2023).

13.2.5 Vessel Traffic Services

Vessel Traffic Services (VTS) coverage within the Severn Estuary is provided by Bristol VTS. This is delivered as two services, the first is an Information Navigation Services (INS) within the wider Severn Estuary and the second is a Traffic Organisation Services (TOS) in the vicinity of Bristol. The area managed by Bristol VTS is shown in Figure 13-15. All vessels (over 50 GT) must monitor the relevant VHF Channels whilst in the VTS area. Vessels below this size are requested to maintain a continuous watch on VHF channel 12 (TBPC, 2018). Bedwyn Sands and NMG are within the INS area of Bristol VTS and, therefore, vessels operating in this area must monitor information and communicate with Bristol VTS.



Source: TBPC (2023)

Figure 13-15 Bristol Port VTS boundaries

13.2.6 Pilotage

Pilotage to the Port of Bristol and ABP South Wales is compulsory for the majority of large vessels (defined as vessels of 85 m Length Overall (LOA)), with pilots generally boarding in an area located to the south-west of Barry. (TBPC, ,2022)

13.2.7 Overview of port activity in the study area

The Port of Bristol is the largest port facility in the Bristol Channel/Severn Estuary and comprises Avonmouth and Royal Portbury Docks, which together consist of 28 berths. The port is owned by TBPC and handles a range of cargoes, including forest products, containers, motor vehicles, metals and steel, fresh products and bulk cargo including coal, animal feeds, grain and liquids. In 2022, the port handled approximately 8.53 Million tonnes, which constituted 1.9% of the UK's port freight (DfT, 2023). A naturally deep navigational channel enables deep draught vessels to reach Portishead Point at most states of the tide, with localised dredging in the port entrance providing access for deep draught vessels throughout 70% of the tidal cycle. The harbour and its operations are designed to accept Cape size vessels of up to 130,000 Deadweight Tonnage (DWT).

The commercial docks at Newport, which are owned by ABP, have a typical annual tonnage of around 2.6 Million tonnes (DfT, 2023). The variety of cargoes handled at Newport includes fresh produce, forest products, general cargo, steel and various dry bulk commodities. Newport can accept vessels of up to 40,000 DWT at its deep-water berths; the limits on vessel size are 244 m length, 30.1 m beam and 10.4 m draught (ABP, 2023).

13.2.8 Recreational navigation

A range of recreational boating activities take place in the wider study area, including keel boat racing/cruising, motor boating and dinghy sailing. Many of these activities are carried out through Royal Yachting Association (RYA) affiliated training centres and yacht/sailing clubs, of which there are several located in the study area. In total, there are five marinas, 20 boat clubs, 26 mooring areas and around 2,440 moorings/berths and 40 slipways in the study area, or immediately adjacent (ASERA, 2016). Large marinas within the wider study area include Bristol (450 berths) and Portishead (250 berths). Cardiff Bay is however the main location for recreational boating in the Severn Estuary, with up to 200 boats per day passing inbound through the barrage during the busiest weekends and between 9,000 and 10,000 boats over a year (ASERA, 2016). Popular sailing clubs in the study area include Newport and Uskmouth Sailing Club, Clevedon Sailing Club and Portishead Yachting and Sailing Club.

Information from the RYA's national dataset of cruising routes, sailing areas, clubs and marinas (RYA, 2019) identifies and classifies a large section of the Severn Estuary as a general sailing area (see Figure 13-16).

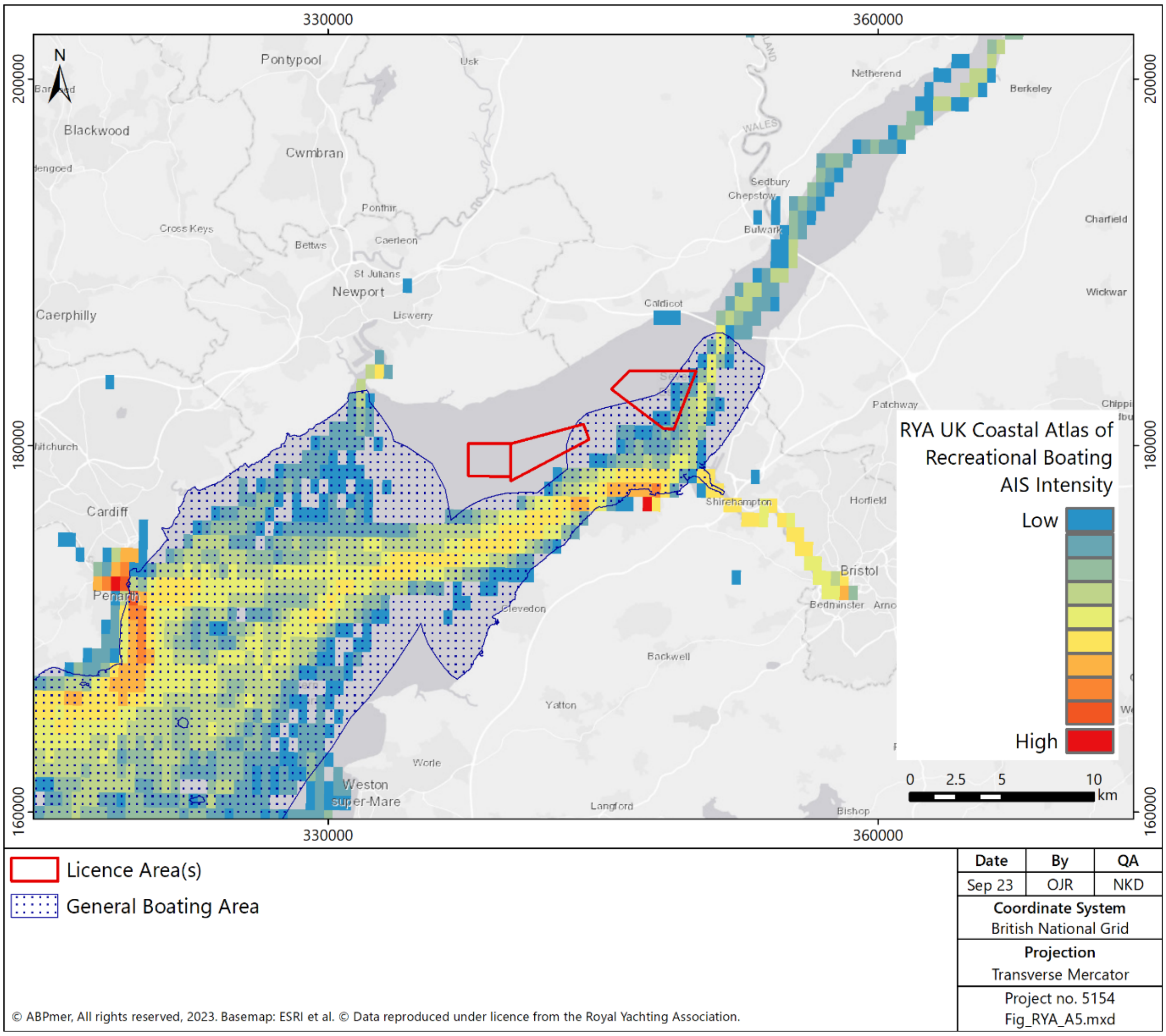


Figure 13-16 RYA Coastal Atlas of Recreational Boating

Only a small portion of NMG fall within the general boating area and a little over half of the Bedwyn Sands area fall within the RYA general boating area. This area is in use for general day-sailing by all types of recreational craft, but particularly smaller craft such as small cruisers, day-boats, dinghies, sailboards and personal watercraft. The RYA has indicated that the proposed operations at Bedwyn Sands and NMG will not significantly increase the risk compared with the existing activity (*pers. Comm.*, 21 June 2023, RYA). Further information on recreational vessel movements is available from the UK Coastal Atlas of Recreational Boating (RYA, 2019), Figure 13-16 which shows recreational density vessel transits within the wider study area as well as the general boating area. It should be noted however, that there is an inherent limitation in using AIS information to characterise recreational vessel movement, as many recreational vessels are not required to carry AIS and thus do not transmit AIS.

The intensity of boating activity in the Estuary is seasonal and influenced by the weather, tides and sea conditions, daylight hours, holidays and events. Levels of boating are highest during the spring, summer and autumn months, particularly during weekends and holidays. Generally, boating occurs during the winter at lower levels with smaller boat numbers, less frequent activity and fewer events. In all locations, the levels of winter boating are low to very low. The exception is at Cardiff Bay and Portishead Quays Marina, which have high and moderate boat movements in the winter respectively. These higher levels of winter boating are related to increased numbers of fishing boats (ASERA, 2016).

13.2.9 Marine incidents in the study area

This section reviews marine incidents that have occurred within the study area over the past 10 years (subject to data availability). The analysis is intended to provide a general indication as to whether the study area is in an area of low or high risk in terms of marine incidents. Data from the MAIB and the RNLI has been obtained and combined into a single dataset:

- MAIB – information includes accident to ships and personnel report to the MAIB within the period of 2013 to 2022 inclusive; and
- RNLI – complete dataset of all callouts from 2013 to 2022 inclusive.

The datasets were amalgamated to create the best available 10 years of information. Where possible, duplication of data has been removed (as the same incident may be recorded by two or more organisations). The MAIB and RNLI datasets has been presented spatially in Figure 13-17 and Figure 13-18. Table 13-4 provides a compiled view of marine incidents within the wider study area over a 10-year period from 2013 to 2022.

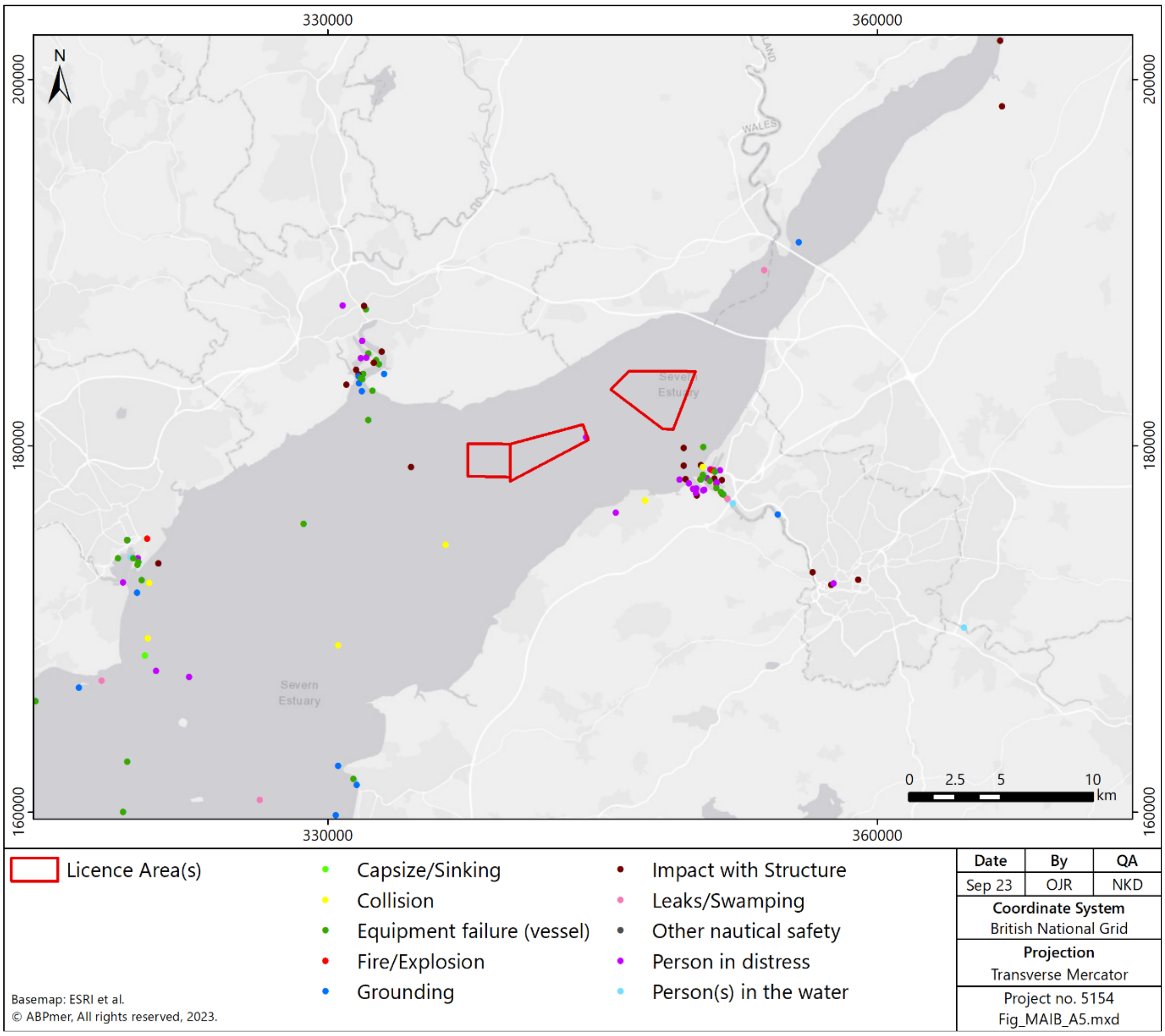


Figure 13-17 MAIB incidents in study area

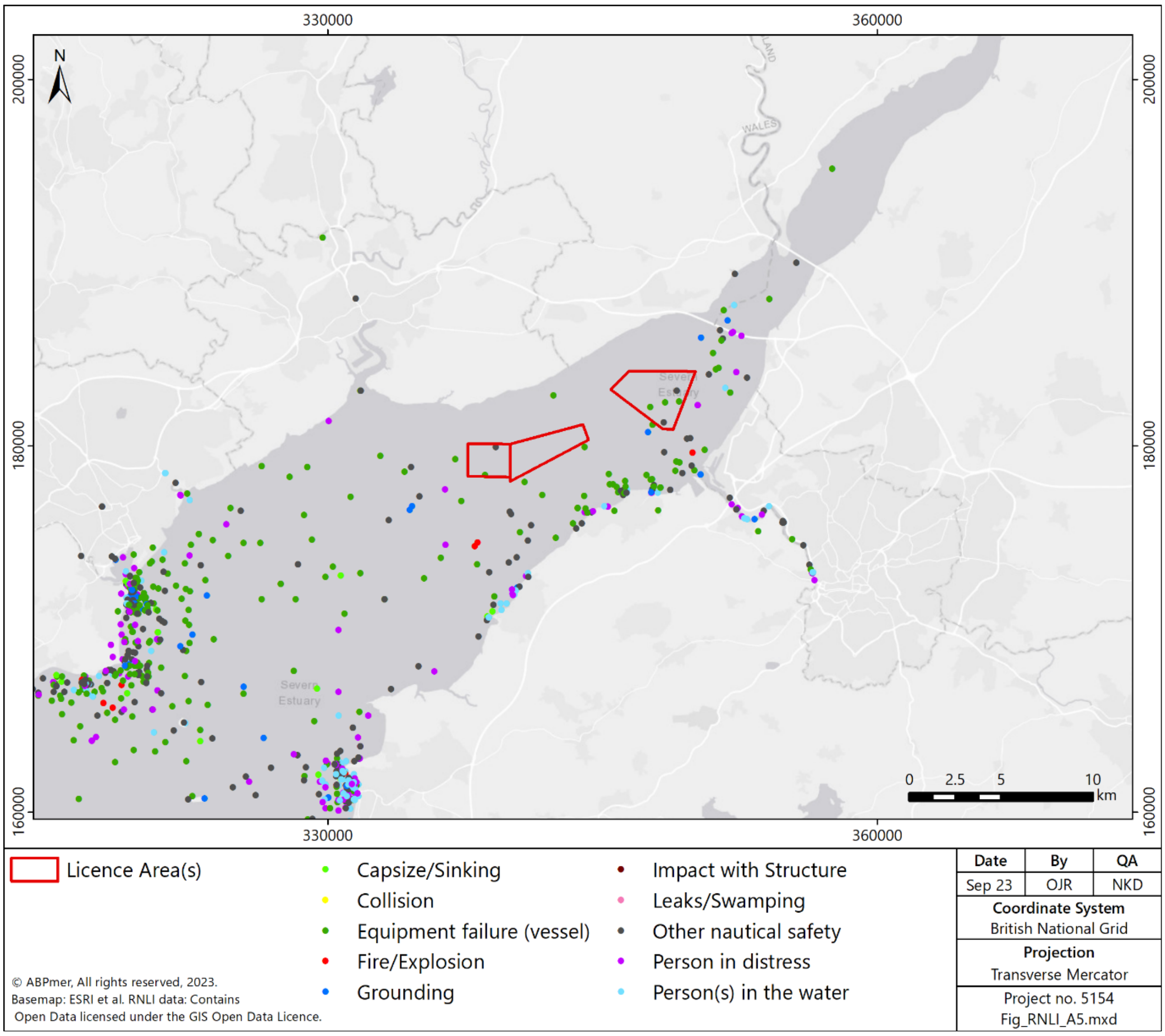


Figure 13-18 RNLI incidents in study area

Table 13-4 Marine incidents within the wider study area

Incident Category	Year										Total	Annual Frequency
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
Capsize/Sinking	2	5	6	5		1	2				21	**2.1**
Equipment failure (vessel)	26	13	27	38	29	25	32	21	29	27	267	**26.7**
Fire/Explosion	0	1	0	6	2	1	0	0	0	2	12	**1.2**
Grounding	6	6	7	8	4	3	5	1	8	3	51	**5.1**
Other nautical safety	1	4	6	8	27	14	20	66	18	33	197	**19.7**
Person in distress	13	12	12	24	25	7	13	15	12	14	147	**14.7**
Person(s) in the water	6	6	10	9	7	3	8	6	18	18	91	**9.1**
Impact with Structure	1	5	4	5	5	2	1	2	1	1	27	**2.7**
Collision	2	0	4	2	0	2	0	2	2	0	14	**1.4**
Leaks/Swamping	0	0	0	0	0	0	0	1	2	1	4	**0.4**
Total	**57**	**52**	**76**	**105**	**99**	**58**	**81**	**114**	**90**	**99**	**831**	**83.1**

Figure 13-17 and Figure 13-18 identifies that there have been two MAIB incidents and seven RNLI incidents recorded within the dredge areas. The two MAIB incidents both fell in Area 459 and are categorised as 'person in distress'. The seven RNLI recorded incidents include three 'equipment failures (vessel)' and two 'other nautical safety' within the Bedwyn Sands area. With Area 455, there was an Equipment failure (vessel) and one 'other nautical safety'.

For the wider study area, the incident record shown in Table 13-4 identifies that there are on average over 83 incidents per year, with 'equipment failure (vessel)' being the most frequent, followed by 'other nautical safety'. It should be stressed that the incident records shown in Table 13-4 are heavily dominated by incidents at and around port facilities and are not related to the existing Licence Areas. Only seven incidents have occurred within the record of incidents within the 10-year dataset.

13.3 Impact assessment

The continuation of aggregate dredging in Bedwyn Sands and NMG has potential to affect commercial shipping and recreational navigation through the following activities and sources:

- **Vessel presence:** This could result in an increased accident or incident risk between the aggregate dredger whilst it is working in Bedwyn Sands and NMG Renewal Areas or transiting to and from the Area with other traffic navigating through the same area. Secondary impacts as a result of an accident are also possible, such as pollution from fuel and oil.

Table 13-5 provides a list of the potential hazards which have been considered when carrying out the impact assessment.

Table 13-5 Hazard log

Hazard
Collision when working in Bedwyn Sands and NMG Areas (between pleasure boats, fishing vessels, commercial vessels and other dredgers working within the area)
Collision transiting between port and Bedwyn Sands and NMG Areas (between the dredger and other vessels)
Contact (between the aggregate dredger and floating objects such as debris, or snagging of the drag head on seabed items (underwater obstructions etc.))
Contact (between the dredger and fixed/moored objects such as navigation buoy or a floating object such as debris)
Fire/explosion (onboard the aggregate dredger due to machinery failure or unexploded ordnance contacted during aggregate extraction)
Equipment failure (to the suction pipe, presenting limitations of manoeuvrability)
Personnel injury (from shipboard operations)
Grounding (of the dredger whilst in transit)
Environmental pollution (from incidents or spillages)

Impact pathways not included in the assessment: All identified impacts pathways relating to commercial and recreational navigation have been taken forward in this assessment.

Impact pathways included in the assessment: The key impact pathways relating to commercial and recreational navigation addressed in the following sections are:

- Aggregate dredger accident or incident in Bedwyn Sands and NMG Areas (Section 13.3.1);
- Aggregate dredger accident or incident whilst on passage between Bedwyn Sands and NMG Areas and berth (Section 13.3.2);
- Displacement of Vessels out of Bedwyn Sands and NMG Areas (Section 13.3.3) and
- Water quality impacts from pollutants resulting from accidents, incidents or spillages (Section 13.3.4).

Throughout, the magnitude of change and the importance of features is considered to be high.

13.3.1 Aggregate dredger accident or incident at Bedwyn Sands and NMG

General context

The presence of an aggregate dredger within Bedwyn Sands and NMG Areas provides an increase in accident and incident risk. Potential risks include:

- Collisions (between pleasure boats, fishing vessels, commercial vessels and other dredgers working within the area);
- Contact (between the aggregate dredger and floating objects such as debris or snagging of the drag head on seabed items (underwater obstructions etc.);
- Grounding (of the aggregate dredger whilst at the licence area);
- Fire/explosion (onboard the aggregate dredger due to machinery failure or unexploded ordnance contacted during aggregate extraction);
- Equipment Failure (to the suction pipe, presenting limitations of manoeuvrability); and
- Personnel Injury (from shipboard operations).

The average future annual extraction values of 35,000 tonnes for Bedwyn Sands and 170,000 tonnes for NMG (Areas 455 and 459) results in a total of 234 cargoes per year and a maximum of 572 cargoes a year as shown in Table 3-2. in Section 3. At maximum extraction this relates to 7,500,000 tonnes over the 15-year licence periods or at the current average 3,075,000 over the 15-year licence. It is expected that the current extraction rate will continue throughout the next licence period and have no change to the current navigational environment.

Bedwyn Sands and NMG Areas are located in a relatively low shipping density area, away from approaches to ports and harbours. There is a significant amount of aggregate dredging in the Severn Estuary, and there have been no recorded incidents involving aggregate dredgers in the existing Licence Areas or personal injuries whilst working aboard the vessels. This is supported by the marine accident and incident statistics (see Section 13.2.9). Furthermore, all dredge areas are located within the boundary of Bristol VTS and are therefore subject to oversight from a navigation service with 24 hour, seven days a week, coverage.

BMAPA, in consultation with the MCA has developed a guide to good practice for ensuring navigation safety during dredging operations which includes a number of risk reduction measures (BMAPA, 2012); Breedon Group, whilst not being a member of BMAPA, adheres to this guide. The dredgers operated by Breedon Group are manned and operated in accordance with international regulations and display the required lights and shapes whilst operating. Whilst dredging, the vessels remain in VHF contact with Bristol VTS, and other vessels are thus aware of the presence and movements of the dredgers.

Impact assessment

The renewed licence for Bedwyn Sands and NMG would result in the continuation of current dredger activity in the area as the movement of the dredger during aggregate extraction would be in the same areas as the current dredge licence and, due to the tidal restrictions, the limited amount of commercial shipping and recreational activity in the area, the probability of the occurrence of an accident is considered to be low. This results in a low exposure to change and a low sensitivity. The impact of dredging activity on commercial and recreational navigation is therefore considered to be **minor adverse**. This means that, in terms of navigational risk, the embedded mitigation provides an outcome which is considered to be as low as reasonably practicable ('ALARP').

13.3.2 Aggregate dredger accident or incident whilst on passage between Bedwyn Sands and NMG and berth

General context

The transit of an aggregate dredger between its berth (discharge berth or lay-by berth) and Bedwyn Sands and NMG Areas creates the potential for collision of the dredger with other vessels, or a marine incident. Possible navigational hazards include:

- Collisions (between the dredger and other vessels);
- Contact (between the dredger and fixed/moored objects such as navigation buoy or a floating object such as debris); and
- Grounding (of the dredger whilst in transit).

The maximum number of cargoes with a 500,000-tonne combined extraction tonnage a year would provide an estimated 572 loads (1,144 vessel movements), however the average future loads per year, based on current values, is 234 (468 vessel movements). This would be a continuation of the current vessel activity at these dredge sites. The typical predicted moves in Bedwyn Sands and NMG Areas are noted in Table 3-2. It should be noted however that the continuation of the current dredge activity would not represent an increase in the percentage of the overall traffic in the study area. A number of navigational controls are in place to improve navigational safety, principally VTS, and dredgers will observe the BMAPA/MCA guide to good practice mentioned above.

Impact assessment

Depending on the route taken, the movement of the dredger vessel to and from the Bedwyn Sands and NMG Areas is unlikely to cause a disruption to general shipping and recreational activities given the available sea room for navigation within the estuary, and the background shipping volume within the study area. Given that the risk of accident or incident involving the dredger whilst on passage between Bedwyn Sands and NMG Areas, and its berth is small and the probability of occurrence is low, the impact of the passage of the dredger on commercial and recreational navigation is considered to be **minor adverse**. This means that, in terms of navigational risk, the embedded mitigation provides an outcome which is considered to be as low as reasonably practicable ('ALARP').

13.3.3 Displacement of vessels out of Bedwyn Sands and NMG

General context

The presence of a dredger may temporarily displace vessels using parts of Areas 455, 459 and Bedwyn Sands. The significance of this displacement depends on the duration and timing of extraction activity and the level of navigational activity that exists within the immediate and wider area. If vessels are displaced out of Bedwyn Sands and NMG and are made to navigate into the main shipping route (especially slow-moving vessels such as yachts), this has the potential to increase the risk of vessel collision. Active monitoring of the area by Bristol VTS, application of the International Regulations for the Prevention of Collision at Sea (COLREGS), VHF communications between vessels whilst underway and experienced Pilots provide a range of inherent risk controls, as does observing the BMAPA/MCA guide to good practice.

Impact assessment

The AIS data shows that there are few commercial traffic movements within the dredge areas and local anecdotal sources suggest there is limited use by water users. Given the temporary nature of any displacement of vessels, embedded risk controls and the fact that there is limited use of this area by other sea users, the potential for incidents due to displacement are remote. The overall impact, therefore, on commercial and recreational navigation is considered to be **minor adverse.** This means that, in terms of navigational risk, the embedded mitigation provides an outcome which is considered to be as low as reasonably practicable ('ALARP').

13.3.4 Water quality impacts resulting from accidents, incidents or spillages

General context

There are potential risks of water quality impacts associated with any vessel accidents, collisions and spillage. These risks will be minimised through existing compliance with the International Safety Management Code which became mandatory with the adoption of the International Convention for the Safety of Life at Sea.

Impact assessment

The absence of incident records relating to water pollution does not remove the risk that may occur in the future; any shipping accident has the potential to lead to a spillage of cargo or fuel/oil from the ship involved. However, data records do provide an indication that operational and existing risk controls are providing adequate safeguards at present. In the context of the minor risk associated with dredger operation and transit, the potential exposure of any resulting pollution from vessel accidents is considered to be low. Overall, therefore, the potential risk of water quality impacts from accidents and spillages is considered to be **minor adverse**. This means that, in terms of navigational risk, the embedded mitigation provides an outcome which is considered to be as low as reasonably practicable ('ALARP').

13.4 Summary and conclusions

Table 13-6 summarises the impact assessment judgements, presents final conclusions on overall impacts across all impact pathways, and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 13-6 Commercial and recreational navigation impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, all features are considered to have a negligible to small magnitude of change with a low probability of occurring resulting in a negligible to low exposure to change.
Estimation of vulnerability	Based on the evidence presented in this assessment it is estimated that the vulnerability of features is low.
Estimation of significance	The evidence provided identified the risk of impact of dredger vessel presence (and transit) on navigational receptors as minor adverse across all pathways.
Conclusion	The potential risk of accidents and incidents relating to the transit and operation of the dredger, potential displacement of any commercial and recreational vessels due to dredger operation within Bedwyn Sands and NMG and the potential for water quality impacts resulting from incidents is considered to be of minor adverse at worst in the context of existing levels of commercial shipping and recreational activity. In line with this scale of significance, the assessment concluded that these impacts are not of a scale requiring further specific mitigation. Thus, with the embedded mitigation, a risk is achieved which is considered to be as low as reasonably practicable ('ALARP').
Confidence Assessment	The assessments were underpinned by AIS data interpretation, accident and incident data from government agencies, NGOs and port organisations. The confidence in the assessment provided in this section, plus the navigational impact review and underpinning baseline data is considered to be high.

13.5 References

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14 Marine Archaeology

This section, which was prepared by Wessex Archaeology Ltd, and provides an overview of the existing and potential marine archaeology assets that have the potential to be impacted by the proposed aggregate dredging activities within Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459). Section 14.1 presents the data sources and organisations/stakeholders consulted to inform the baseline and assessment. Baseline information is provided in Section 14.2, Section 14.3 comprises the impact assessment and Section 14.4 presents a summary and conclusions.

The study area for this assessment is the area over which potential direct and indirect effects of the proposed aggregate dredging activities are predicted to occur.

Marine archaeological receptors considered within this section are seabed prehistory and seabed features including maritime sites, aviation sites and any associated material.

The supporting marine archaeology desk-based assessment (DBA) (Wessex Archaeology 2023) should be read in conjunction with this section and is presented in Appendix F of this ES. The DBA comprised a desk-based study of the environmental baseline for marine archaeology, within Bedwyn Sands and NMG Renewal Areas and the wider Severn Estuary. The DBA also considered the historic seascape character of the wider area and provides a review of the legislation, policy and guidance of relevance to this EIA.

14.1 Data sources and consultation

14.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- The United Kingdom Hydrographic Office (UKHO) data for charted wrecks and obstructions;
- The National Marine Heritage Record (NMHR) maintained by Historic England, comprising data for terrestrial and marine archaeological sites, find spots and archaeological events;
- National Heritage List maintained by Cadw, comprising data of designated heritage assets including sites protected under the Protection of Military Remains Act 1986 and the Protection of Wrecks Act 1973;
- National Monuments Record of Wales (NMHR) maintained by Coflein, comprising data of terrestrial and marine archaeological sites, find spots and archaeological events;
- Relevant Historic Environment Records (HER) from Glamorgan-Gwent Archaeological Trust (GGAT);
- Records of recovered archaeological material from within the study area and reported via the Marine Aggregates Industry (MAI) Protocol for Reporting Finds of Archaeological Interest (BMAPA *et al.*, 2005);
- Datasets comprising the Historic Seascape Characterisation (HSC): Consolidating the National HSC Database (LUC 2017) and Marine Character Area for Severn Estuary (NRW 2015);
- Bedwyn Sands Environmental Statement (ABPmer, 2015) containing information regarding recorded maritime sites;
- North Middle Ground Environmental Statement (ABPmer, 2016) containing information regarding recorded maritime sites;
- Relevant mapping including Admiralty Charts, historic maps and Ordnance Survey; and
- Relevant documentary sources and grey literature held by Wessex Archaeology, and those available through the Archaeological Data Service and other websites.

14.1.2 Consultation

Consultation with regard to the outcomes of the formal scoping process and whether there are any likely effects of the dredging proposal on marine archaeology has been undertaken as appropriate, with NRW (Cadw and the RCAHMW) and MMO.

The consultation that has been undertaken, along with the outcome of such consultation and how it has influenced this assessment is provided in Table 14-1.

Table 14-1 Summary of consultation to date

Consultee	Reference, Date	Summary of Response	How Comments Have Been Addressed in this Chapter
MMO	EIA/2022/00044 17/04/2023	MMO understand a desk-based assessment will be commissioned for the DBA and completed by a CIfA registered organisation. The MMO point out that it may be beneficial for the archaeological contractor to consider the coverage, quality and techniques of geophysical survey data previously acquired for monitoring purposes.	A DBA has been compiled to inform the ES. See Appendix F.
MMO	EIA/2022/00044 17/04/2023	MMO welcome the cumulative and in-combination assessment to address known developments and activities occurring in the wider regional context to assess the potential impacts upon the historic environment	This is addressed in Chapter 19.
MMO	EIA/2022/00044 17/04/2023	The ES must also include detail on the required mitigation and monitoring strategies to be adopted, with reference to procedures detailed in BMAPA *et al.*, 2005 guidance.	This is referred to in Section 14.3.1 of this chapter
MMO	EIA/2022/00044 17/04/2023	To archive any archaeological reports via OASIS.	Any reporting will be archived via OASIS. See Appendix F.
NRW	Ref SC2204 03/02/2023	Cadw and the RCAHMW agree with the assessment as proposed.	Noted

14.2 Review of baseline understanding

As described in Section 5.2, Bedwyn Sands and NMG (Licence Areas 455 and 459) are predominantly intertidal sandflat features, located within the Severn Estuary. Bedwyn Sands is an intertidal 'sand flat' rather than a classic 'sand bank', as it lacks a distinctive crest. It is composed of sediments which range from sand to pebble-sized material, which are sorted as a result of tidal flows over the area. It is the well-sorted medium sand that is of particular interest to the aggregate industry. Previous studies (e.g. McLaren and Collins, 1989) have identified that sand moves freely between the sandbank features of the Severn Estuary, driven predominantly by the asymmetry of the tide, and is in a continual state of re-working giving significant depths of material across the three licence areas.

The three licence areas cover approximately 19.8 km^2.

Marine archaeology receptors will be considered against the following categories:

- Prehistoric Archaeology: this comprises land surface with evidence of human activity, including now-submerged landscape features, artefacts, sites and find-spots that date from the earliest occupation;
- Maritime Archaeology: maritime archaeological sites consist broadly of vessel remains, wreckage and submerged vessel/cargo debris; and
- Aviation Archaeology: this comprises all military and civilian aircraft crash sites and related wreckage.

The full baseline resource of marine archaeology, which included known wrecks and obstructions, the potential for further maritime and aviation archaeological receptors, and potential seabed prehistory are presented and illustrated in the marine archaeology DBA included in Appendix F. The subsections below present a summary baseline description of the relevant marine archaeology receptors.

14.2.1 Prehistoric archaeology

There are no known prehistoric receptors within the study area. However, features such as these have been previously identified within the vicinity of the Renewal Areas, including Mesolithic sediments at Brue Valley on the Somerset Levels and the Gwent Levels Historic Landscape Area on the Welsh coast. The Severn Estuary has one of the richest and most varied archaeological landscapes in Europe (Sturt *et al*., 2016). It is possible that further remains relating to such early human activity are present in the study area, particularly if organic-rich deposits are encountered. Surviving evidence of prehistoric activity on the seabed can manifest as landscape features (commonly linked to subsistence strategies), palaeo-environmental remains, or physical artefacts such as worked flints.

In general, on the basis of their age and rarity in a marine context, all *in situ* Palaeolithic and Mesolithic material are likely to be of high archaeological value and of national / international importance. Sites containing certain forms of Palaeolithic material are so rare in Britain that they should, whenever possible, remain undisturbed. In the event that prehistoric archaeological material is discovered *in situ,* it should be considered of particularly high archaeological importance. As such, the features and deposits which have the potential to contain within them in situ material should be considered as high value assets.

It is assumed that most prehistoric archaeological finds from the Bristol Channel will be of Palaeolithic or earlier Mesolithic date (see Bell, 2000; Bell *et al*., 2000). The recovery of material from later periods (i.e. since 8,000 BP) will generally be confined to intertidal and nearshore locations due to their post-dating the principal episode(s) of Holocene marine transgression (Sturt *et al*., 2013). In practical terms, post-depositional factors can dictate that very little material will be in primary context, and it will retain the similarly limited spatial and temporal integrity as terrestrial assemblages, thus restricting the level of interpretation that can be attempted.

Although out of context, any recovered prehistoric material would almost certainly have the potential to provide insights into patterns of past human land use and demography (Hosfield *et al*. 2009).

14.2.2 Maritime and aviation archaeology

There are no sites within the study area that are subject to statutory protection from the Protection of Wrecks Act 1973, the Protection of Military Remains Act 1986 or the Ancient Monument and Archaeological Areas Act 1979; the three principal statutes that could be used to protect marine archaeological sites.

No records were found within the datasets of the NMRW and GGAT HER. There is one reported maritime site charted by the UKHO located at the upper edge of NMG Area 459. This consists of the British tug *Mercia*. This has not been found in searches since.

Full details are provided in Appendix F and illustrated in Figure 2 of the DBA (included in Appendix F).

14.2.3 Archaeological potential at NMG and Bedwyn Sands

Maritime archaeological potential

The assessment of potential for the discovery of shipwreck and shipwreck-derived material within the study area draws on the results of the desk-based research combined with further research of the wider area.

The study area falls within an area of significant shipping and navigation activity. These include the passage of merchant vessels, recreational craft, military vessels, and vessels engaged on specialist operations such as aggregate dredgers.

Recorded Losses can be considered as an indication of the potential for archaeological maritime remains to exist within the study area and the type and number of wrecks that could be present. These records relate to vessels reportedly lost or for which no physical wreck remains have ever been identified.

Although no documented wrecks are located within the study area, a number of vessels have been recorded as lost within the vicinity of the study area, including the iron hulled sloop Charlotte (NPRN_515718) and iron hulled steamship Nathan (NPRN_274711), both 19th Century vessels.

In addition to the charted maritime sites and Recorded Losses, there is also the potential, in principle, for the presence of archaeological material of a maritime nature, currently uncharted, to exist within the study area spanning from the Mesolithic period to the present day.

The Bristol Channel which leads into the Severn Estuary, an area that has historically been synonymous with shipping, has been traversed by a vast number and diverse array of boats and ships, ranging from prehistoric craft to modern warships and submarines. These vessels embody some of the most complex attributes of any society, not only in terms of their technology but also their organisation, communication and trade. The study area is located within a navigational corridor which was used by ships accessing the English ports of Bridgwater and Bristol, and the Welsh ports of Newport and Cardiff. In this capacity, the maritime prominence of the Bristol Channel provided access to, and intensive usage of, the Irish Sea, Western Atlantic, and English Channel as major shipping routes from the late medieval period up to the present day. Many of these ports became major conurbations during the late medieval period and the intervening centuries saw expanding trade and industry with a resultant increase in the commercial use of the Severn Estuary, which continues to facilitate a large volume of maritime traffic (MarineSpace *et al.*, 2012).

Wrecks have been identified within the Severn Estuary covering various periods of history. For example, a Bronze Age boat has been recorded at Caldicot and a Roman boat found close to the inland margin of the levels at Magor, Gwent, from what was then a tidal creek. Similarly, the 'Newport Ship' was discovered during the excavation for a new arts centre in Newport and is one of the most complete examples of a late medieval ship, believed to be built *circa* 1465 (Severn Estuary Partnership, accessed September 2023).

Whilst potential is certainly reflected in the recorded losses and shipping casualties within the immediate vicinity of the study area, there is the potential for further maritime wreck material to survive in situ.

The key elements of maritime potential that may be uncovered within the study area are summarised in the accompanying DBA (Appendix F).

Aviation archaeological potential

The assessment of potential for the discovery of aircraft crash sites and aircraft derived material within the study area draws on the results of the desk-based research combined with further research of the wider area.

There are no known aircraft crash sites recorded in the study area.

There is potential for the presence of aviation material dating from the early 20th century until more recent times, with a concentration dating to the World Wars and in particular the Second World War, 1939-45.

The key elements of aviation potential that may be uncovered within the study area are summarised in the accompanying DBA (Appendix F).

All aircraft that crashed while in military service are automatically protected under the Protection of Military Remains Act 1986. If present, such sites would represent statutory constraints upon the proposed development. This legislation means any activities impacting upon the aircraft remains must cease pending assessment by the Ministry of Defence (MoD).

14.3 Impact assessment

14.3.1 Introduction

This section aims to determine the potential impact pathways that may occur during dredging activities within Bedwyn Sands and NMG and assess the significance of the effects, both positive and negative, on marine archaeological receptors located within the study area.

The following dredging activities within Bedwyn Sands and NMG have the potential to cause the following impact pathways and associated effects:

- **Draghead** – the action of the draghead on and beneath the seabed may cause direct damage/destruction/dispersal to marine archaeological receptors in these locations. Dredging activities may also change the seabed bathymetry which can subsequently impact the sediment transport regimes around archaeological sites disturbing relationships between archaeological artefacts and their contexts and potentially exposing such material to increased erosion or corrosion.
- **Overspill** and **Screening** – re-deposition of sediments following settling of sediment plumes caused during the overspill and screening processes may contribute to the preservation of marine archaeological receptors by increasing the layer of sediment that covers and protects the receptors.

Impact pathways not included in the assessment: All identified impacts pathways relating to marine archaeology have been taken forward in this assessment.

Impact pathways included in the assessment: The key impact pathways relating to marine archaeology which are addressed in the following sections are:

- Direct damage to the marine archaeological resource (Section 14.3.2); and
- Indirect damage to the marine archaeological resource (Section 14.3.3).

Negative or adverse impacts to archaeological receptors occur as a result of changes to their physical environment in terms of loss, change and/or degradation, which can subsequently reduce the significance of a receptor and its wider historic environment. The management and mitigation of such change is based on the principle that archaeological receptors are finite, non-renewable and cannot adapt, tolerate or recover from direct impacts.

Positive or beneficial impacts may also occur to archaeological receptors as a result of changes to their physical environment in terms of an accumulation of sediment that provides further protection to the receptors.

Prior to the impacts being assessed, existing mitigation measures and the sensitivity and value of the assessed receptors are discussed below. Please note that cumulative and in-combination impacts on archaeological receptors with other projects and activities are assessed in Section 19.

Existing mitigation

There are industry-wide mitigation measures already in place to prevent significant impacts to marine archaeological material. The key mitigation to reduce the significance of effects with regard to the loss of unexpected archaeological material within the volume of aggregate, and to deal with new discoveries once they occur, is the Marine Aggregates Industry Protocol for Reporting Finds of Archaeological Interest, hereafter referred to as the 'Protocol' (BMAPA *et al.*, 2005).

Isolated finds reported through the Protocol are logged and details are submitted to the relevant national curators and archives via Historic England or Cadw and RCAHMW and to the appropriate Historic Environment Record (HER). Continued awareness of, and adherence to, the Protocol is considered to sufficiently address the effect of the loss of archaeological material within the volume of aggregate so that this impact is not significant.

To date, no archaeological material from Bedwyn Sands and NMG Renewal Areas has been located and reported to either the BMAPA Protocol, Cadw or GGAT. Should any archaeological find occur in the future, the archaeological reports will be recorded via OASIS.

If discoveries indicate the presence of an *in situ* prehistoric, maritime or aviation site, or a significant artefact assemblage, the Protocol includes the provision for the application of Temporary Exclusion Zones (TEZs). TEZs prevent further impacts from occurring until additional archaeological assessment and, if required, investigations, can take place and appropriate advice obtained.

A further standard approach to mitigation is the use of Archaeological Exclusion Zones (AEZs) to prevent direct impacts to known archaeological receptors. AEZs are generally considered on a site-by-site basis depending on the nature and significance of the archaeological material, however they can comprise a 100 m buffer around the extents of the material, for example, a prehistoric site, wreck, aircraft or anomaly. No dredging related activities are permitted within an AEZ, and as a result no impacts will occur.

There is currently one precautionary AEZ already in place within Area 459. This consists of a 100 m buffer around the central location of UKHO 12587. It was established as part of the 2016 EIA (ABPmer, 2016).

Sensitivity / value of the receptors

Since archaeological receptors cannot generally adapt, tolerate or recover from physical impacts, the sensitivity of each receptor is therefore mainly quantified by their sensitivity or archaeological value.

The desk-based assessment indicated:

- The known site (UKHO 12587) consisting of the dispersed remains of the steel-built tug *Mercia*, considered as medium archaeological value,
- Undiscovered wrecks are considered as high value potential receptors,
- Undiscovered aircraft sites are considered as high value potential receptors,
- Undiscovered prehistoric sites are considered as high value potential receptors.

The rationale and archaeological value of these receptors is discussed further in the DBA (Appendix F).

14.3.2 Direct damage to the marine archaeological resource

General context

Archaeological receptors may be buried within seabed sediments or may rest upon the seafloor, either with or without height. As such, direct impacts to these receptors can occur during any dredging or related activities that make contact with the sea floor or truncate seabed deposits. Archaeological receptors with height, such as wrecks, may also be impacted by dredging activities that occur within the water column. It is to be noted that the mobile nature of the sands in this area may periodically expose *in situ* seabed features making them more vulnerable to erosion and relocate objects from the area. However, there is also the possibility of derived archaeological materials being present that have been transported into the area by the dynamic environment. Therefore, potential exists for the presence of both *in situ* and derived archaeological material.

Direct impacts include damage to both known and currently unknown archaeological deposits and material, and/or the disturbance or destruction of relationships between deposits and material and their wider surroundings. During dredging activities, direct impacts may be caused by the draghead to material on or buried within the seabed and also material that is collected along with aggregate and transferred to the hopper.

Impact assessment

The application of existing mitigation described in Section 14.3.1 means that all direct impacts to known receptors would be avoided and, hence, would be insignificant.

The magnitude of direct physical impacts to unknown, potential marine archaeological receptors is considered to be major adverse as these potential receptors are judged to be of high importance and as the assessment of their exposure to change and estimation of vulnerability cannot be assessed for potential receptors, this is judged to be high.

Residual impact significance for unknown, potential receptors is considered to be **minor adverse** for direct impacts provided that mitigation measures, including implementation of AEZs to protect high value receptors, implementation of the Marine Aggregate Industry Archaeological Protocol for unknown assets and monitoring assessments, are embedded and undertaken.

14.3.3 Indirect damage to the marine archaeological resource

General context

Potential indirect impacts to both known and currently unknown archaeological deposits or material may be caused by the removal of substrate together with changes to hydrodynamic and sedimentation patterns caused by the dredging activities. This impact may lead to material gaining increased protection from the addition of sediment deposition, or to material being exposed or destabilised, causing potential damage/destruction. In general, archaeological receptors exposed to marine processes will deteriorate faster than those buried within seabed sediments.

Impact assessment

From annual monitoring assessments of regional bathymetry survey data shows that the area has exhibited little change in bed elevation (ABPmer, 2022). Patches of higher change are exhibited over the western and southern extents, where the Bristol Deep channel is likely shifting into the southern flank of the Middle Grounds. These changes are evidence of the dynamic nature of the wider sandbank features of the Middle and Welsh Grounds (ABPmer, 2022).

With regards to indirect physical impacts related to scour, sensitivity is considered to be high. Conversely, archaeological receptors are considered to have high sensitivity towards changes to seabed levels where they are subject to increased burial, typically regarded overall as a beneficial effect.

The value of the one known maritime site (UKHO 12587) is judged to be medium. Estimating its exposure to indirect change, within the dredging area is judged to be low to negligible leading to a situation of insignificant adverse effects.

According to Section 5 (Physical Processes), it is highly unlikely that the proposed extraction of aggregates from the study area will have significant effects on the physical processes of the wider area, including sediment transport, and therefore the magnitude of change and probability of occurrence of indirect impacts to marine archaeological receptors is expected to be negligible. The significance of indirect effects to archaeological receptors is expected to be insignificant.

With regard to indirect disturbance to receptors by screening and overspill activities, and these causing changes to hydrodynamic patterns and erosion, the proposed mitigation for known and potential prehistory receptors, maritime receptors and aviation receptors is future monitoring assessment. Applying this measure is considered to lead to an insignificant residual impact.

The same mitigation measure would also lead to an insignificant residual impact regarding the 'indirect re-deposition of sediments following settling of sediment plumes causing greater sediment cover' and known and potential prehistory receptors, maritime receptors and aviation receptors.

14.4 Summary and conclusions

Table 14-2 provides a summary of the impact assessment findings, presents final conclusions on the overall impacts across all impact pathways, and explains the confidence levels in the assessments and evidence given. For this section, an assessment methodology developed by Wessex Archaeology with reference to archaeological guidance was applied. This methodology is presented in Section 3.4 of the DBA (Appendix F).

Table 14-2 Marine archaeology impact assessment summary and conclusion

Assessment	Summary
Magnitude	The magnitude of direct physical impacts to known marine archaeological receptors is considered to be negligible. The magnitude of direct physical impacts to unknown marine archaeological receptors is considered to be minor adverse. The magnitude of indirect physical impacts to known and unknown marine archaeological receptors is considered to be negligible. With reference to the physical processes assessment, the magnitude of effect of indirect impacts is expected to be negligible.
Sensitivity	All known and potential receptors and associated material should be regarded as having high sensitivity towards direct physical impacts. With regards to indirect physical impacts related to scour, sensitivity is also considered to be high. Conversely, archaeological receptors are considered to have high sensitivity towards changes to seabed levels where they are subject to increased burial – this is regarded as a beneficial effect.
Estimation of significance	The value of the identified receptors ranges between medium for known/named marine archaeological receptors and high for unknown marine archaeological receptors. Without mitigation, direct impacts could result in major adverse effects. The significance of indirect impacts to archaeological receptors is expected to be negligible/insignificant. Residual impact significance is considered to be minor adverse for direct impacts provided mitigation measures are adhered to (exclusion zones, MAI Protocol). For indirect impacts, insignificant residual impacts are assumed provided future monitoring assessment is applied.
Conclusion	Based on the proposed mitigation measures, it is considered that the residual overall impact on marine archaeological receptors can be reduced to minor adverse effects.
Confidence Assessment	The confidence in the compilation of the DBA and impact assessment presented here is considered to be high. The data obtained from archives databases are considered to be good as the UKHO charted wreck records contain previous survey information that provides important context for gauging their archaeological value and sensitivity. Understanding the magnitude of effect upon known and potential marine archaeological material is considered to be good. The sensitivity appraisal of the known resource is also good, whereas there is still uncertainty as to the quantity, location and value of the unknown resource within the study area. The existing and recommended mitigation presented are well established measures and therefore confidence in these is also good.

14.5 References

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15 Coastal Protection and Flood Defence

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on coastal protection and flood defence receptors. Section 15.1 outlines the data sources and organisations/stakeholders consulted to inform the baseline and assessment. Sections 15.2 and 15.3 cover the baseline and impact assessment relating to coastal protection and flood defence, respectively and Section 15.4 provides a brief conclusion.

15.1 Data sources and consultation

15.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- Severn Estuary Shoreline Management Plan (SMP);
- UK Climate Projections (UKCP18); and
- Local flood risk strategies.

15.1.2 Consultation

Table A-1and Table A-2 in Appendix A summarise the aspects raised during the scoping review, and where and how these were addressed. With regard to coastal protection and flood defence receptors, no comments were made in the formal responses.

15.2 Review of baseline understanding

15.2.1 Flood risk

The roles and responsibilities of different flood risk management authorities are set out in the Flood and Water Management Act, 2010. Operational management of coastal protection structures lies largely with District and Unitary Councils; however, the Environment Agency is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion in England (and previously Wales). The Environment Agency has permissive powers to maintain and improve water levels on main rivers, overseeing management and funding coast protection works.

In England, the National Planning Policy Framework (Department for Communities and Local Government, 2023) recognises that properly prepared assessments of flood risk will inform the decision-making process at all stages of development planning and directs development away from areas at highest flood risk.

Since the merger of the Countryside Council for Wales (CCW), Environment Agency Wales and the Forestry Commission Wales in 2013, NRW has assumed the responsibilities of the Environment Agency in Wales, including coastal protection and flood defence. The Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management (2020) sets the following overarching objectives for the management of flood and coastal erosion risk in Wales:

- Reduce the consequences for individuals, communities, businesses and the environment from flooding and coastal erosion;
- Raise awareness of and engaging people in the response to flood and coastal erosion risk;

- Provide an effective and sustained response to flood and coastal erosion events; and
- Prioritise investment in the most at-risk communities.

15.2.2 Shoreline management plans

A SMP is a non-statutory policy document for coastal flood and erosion risk management planning. It takes account of other existing planning initiatives and legislative requirements and is intended to inform wider strategic planning. The current coastal defence strategies for the adjacent coastline of Gwent, Gloucestershire and Bristol (i.e. surrounding the Bedwyn Sands and NMG Licence Renewal Areas) are set out in the Severn Estuary SMP (Severn Estuary Coastal Group (SECG), 2010).

The network of SMPs in England and Wales forms an important element of Defra and Welsh Government strategies for flood and coastal defences. In general, SMPs recommend shoreline management policies for coastal management units, defined by coastal processes, existing defences and risks associated with social, economic, and conservation value. Shoreline management policy options for the area include a combination of hold the line, managed realignment and no active intervention; the current (short-term) SMP management practices relevant to the adjacent coastline are shown in Figure 15-1.

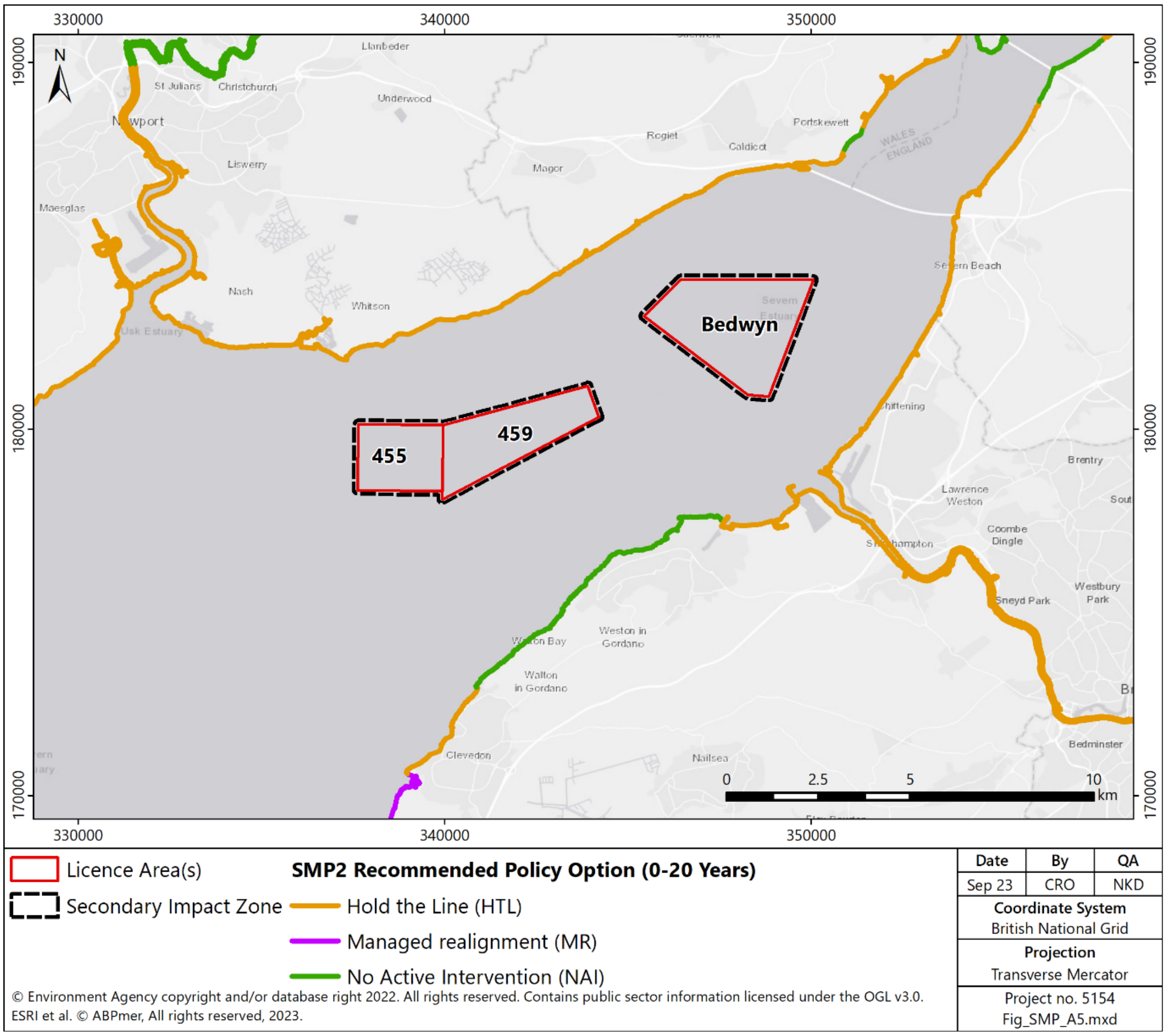

Figure 15-1 Shoreline Management Plan Recommended Policy Options in study area

Bedwyn Sands and NMG are within the Severn Lower transitional water body, located within the Severn River Basin District, and is designated as heavily modified as a result of flood defence (Water Watch Wales, 2021) (see Section 6 for further detail).

15.2.3 Climate change

The generic impacts of climate change on the marine environment are well-documented (e.g. sea level rise) and could lead to increased pressure on coastal defences and increased risk of flooding. There are varying predictions of the magnitude of future change, and modelled outputs rely heavily on various assumptions (e.g. CO_2 emissions).

The latest guidance documents for England and Wales are provided in Environment Agency (2022) and Welsh Government (2021) respectively. The guidance documents include changes to peak rainfall intensity levels and sea level rise allowances for different points in time over the next century in accordance with the UK Climate Projections 2018 (UKCP18). UK Climate Projections is a climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme. The UKCP18 project uses cutting-edge climate science to provide updated observations and climate change projections out to 2100 in the UK and globally (Met Office, 2022).

Both documents developed 'higher central' and 'upper end' sea level rise allowances for each river basin district and epoch for sea level rise. These are based on percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level. For example, for the Severn River Basin District, the higher central sea level rise scenario is expected to lead to approximately 1.21 m of sea level rise between 2000 and 2125, and the upper end sea level rise scenario is expected to lead to 1.62 m of sea level rise over the same period.

15.3 Impact assessment

Aggregate extraction in Bedwyn Sands and NMG has the potential to affect coastal protection and flood defence through the following pathway (and potential effects):

- **Draghead**: Seabed removal represents an important benefit by providing a sustainable source of aggregate which could be used for coastal defences and beach nourishment. Conversely, the removal of sediment could affect the seabed height, resulting a change in wave exposure at the coast.

Impact pathways not included in the assessment: No pathways have been excluded from this assessment.

Impact pathways included in the assessment: The key impact pathways relating to coastal protection and flood defence are:

- Potential for maintaining source of aggregate for coastal defences and beach nourishment (Section 15.3.1); and
- Potential for changes to wave height/exposure to affect coastal protection/flood defence (Section 15.3.2).

15.3.1 Potential for maintaining source of aggregate for coastal defences and beach nourishment

General scientific context

With potential increased storminess and gradual sea-level rise resulting from climate change, coastal erosion is a growing problem. Beaches have the potential to reduce the capability of waves to erode the coast by absorbing their energy as they approach land. The process of recharging beach material with marine aggregates is a well-established practice dating back to the 1960s. Over 90 Mt of marine aggregates have been supplied for beach nourishment and contract fill, including land reclamation projects as well as sea defence, since the late 1960s (Highley *et al.*, 2007; recent BMAPA annual reports). The tonnage of aggregates used varies from year to year, reflecting demand from individual schemes.

Beach recharge presents a cost-effective option for protection, particularly where man-made structures are preventing the natural movement of sediment along the coast. Marine aggregates can also be sourced in relative proximity to the scheme and large volumes can be pumped directly from the dredger to the beach, providing important environmental as well as economic advantages.

Marine aggregate material for use in beach recharge has to meet strict specifications, with the principal objective being to closely replicate the existing beach materials for aesthetic and engineering purposes. Materials range from pure sand to pure gravel, with an increasing trend towards increasing the coarser fraction providing a more stable beach that does not erode as rapidly. Material unsuitable for construction should ideally be used but in many cases high-quality aggregate is necessary to meet engineering design requirements (Highley *et al.*, 2007).

Impact assessment

Historically, material from a nearby (surrendered) Licence Area (Area 377/379/381, Holme Sand) has been used for coastal defences and beach nourishment. It is therefore feasible that the type of sediment extracted from Bedwyn Sands and NMG could be used for such purposes in the future.

Large volumes of aggregate are furthermore required for large- and small-scale schemes for both hard defence construction and fill purposes. Marine dredged sand and gravel represents an obvious choice and is likely to play an important role in the provision of construction aggregate for long-term coastal protection due to the coastal locations of such developments and the scale of supply required.

Bedwyn Sands and NMG have the potential to provide a sustainable source of aggregate and an important potential benefit for the region. Given that impacts on the coast due to physical processes changes have been assessed as insignificant (see Section 5.4), the overall potential impact of aggregate dredging at Bedwyn Sands and NMG Licence Renewal Areas on coastal defences and beach nourishment is considered of **minor beneficial significance**. This is based on a low exposure to change assessment, together with a low to moderate vulnerability assessment and a moderate to high importance assigned to the 'coast' feature.

15.3.2 Potential for changes to wave height/exposure to affect coastal protection/ flood defence

General scientific context

There is a potential risk that a net lowering of the seabed, as a consequence of the aggregate extraction at Bedwyn Sands and NMG Licence Renewal Areas, could lead to increased wave activity along the coast. This risk presumes that removal of sands results in a net lowering of the seabed such that waves can more freely move to the coast with reduced friction and wave energy dissipation. It further assumes that any lowering of the bed within the Licence Renewal Areas is slow to recover (or does not recover at all), leaving the leeward foreshore more exposed to the local wave climate.

Impact assessment

As discussed in Section 5.4, there are not expected to be any effects on the adjacent coastlines due to changes in wave height and tidal currents; nor are there anticipated to be any reductions in beach volume from draw-down of the material into dredged areas. There is also no indication that the present and ongoing aggregate dredging activities have previously significantly altered elevation of the area. The coastal processes assessment also determined that there is not expected to be any significant effects on the English and Welsh coastlines due to changes in wave height and tidal currents; nor are there anticipated to be any reductions in beach volume from draw-down of material into dredge areas.

Given that the probability of occurrence and magnitude of change are both considered negligible, the exposure to change is negligible. Therefore, the overall impact of dredging activities at Bedwyn Sands and NMG on coastal protection and flood defences is assessed as **insignificant**.

15.4 Summary and conclusions

Table 15-1 summarises the impact assessment judgements, presents final conclusions on overall impacts across all impact pathways, and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 15-1 Coastal defence impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, it is considered that the impact pathways associated with coastal protection and flood defence are subject to a negligible to small exposure to change.
Estimation of vulnerability	Based on the evidence in this assessment, it is estimated that the vulnerability of coastal protection and flood defence features is 'none'.
Estimation of significance	Considering evidence presented in this assessment, with reference to Section 5 , the estimation of significance is insignificant (re. wave height exposure') to minor beneficial (re. beach nourishment).
Conclusion	The assessment has concluded that, as dredging activities at Bedwyn Sands and NMG are not expected to impact the coast (in relation to changes in wave height and tidal currents as well as beach draw down) but provide a sustainable source of aggregate for coastal defence works (including nourishment), the overall impact with regard to coastal protection and flood defence would be **minor beneficial** (at best).
Confidence Assessment	Confidence in the assessment is high given the high confidence in the underlying assessment presented in Section 5.4.

15.5 References

Environment Agency (2022) Guidance Flood risk assessments: climate change allowances. [Online] Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed September 2023].

Highley, D.E., Hetherington, L.E., Brown, T.J., Harrison, D.J., and Jenkins, G.O. (2007) The strategic importance of the marine aggregate industry to the UK, British Geological Survey Research Report OR/07/019. ISBN 978 0 85272 608 2.

Met Office (2022) What is UKCP? [Online] Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/about/what-is-ukcp [Accessed September 2023].

Department for Communities and Local Government (DCLG) (2023) National Planning Policy Framework. [online] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed September 2023]

Severn Estuary Coastal Group (SECG) (2010) The Shoreline Management Plan [Online]. Available at: https://www.severnestuarycoastalgroup.org.uk/shoreline-management-plan/ [Accessed September 2023].

Water Watch Wales (2021) Water Watch Wales Map Gallery: WFD Cycle 3 Rivers and waterbodies [Online]. Available at: https://waterwatchwales.naturalresourceswales.gov.uk/en/index.html. [Accessed September 2023].

Welsh Government (2021) Flood Consequences Assessments: Climate change allowances Flood Consequences Assessments: Climate change allowances. Available at: https://www.gov.wales/sites/default/files/publications/2021-09/climate-change-allowances-and-flood-consequence-assessments_0.pdf [Accessed September 2023]

16 Air Quality

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on air quality receptors. Section 16.1 outlines the data sources and organisations/stakeholders consulted to inform the baseline and assessment.

Sections 16.2 and 16.2.1 cover the baseline and impact assessment relating to air quality, respectively and Section 16.4 provides a brief conclusion.

A definition of the study areas applied for in this ES is provided in Section 4.1 For the purposes of this assessment, the wider study area encompasses the Severn Estuary and Bristol Channel.

16.1 Data sources and consultation

16.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- Air quality review and assessment reports from local authorities; and
- Defra Air Quality Management Areas (AQMAs) website (Defra, 2022).

16.1.2 Consultation

Table A-1 and Table A-2 in Appendix A summarise the aspects raised during the scoping review, and where and how these were addressed. With regard to air quality receptors, no comments were made in the formal responses.

16.2 Review of baseline understanding

The UK National Air Quality Strategy (AQS) (Defra, 2007) sets objective values for key pollutants as a tool to help Local Authorities manage local air quality in accordance with the EU Air Quality Framework Directive. This Strategy has been supplemented by the Clean Air Strategy 2019 (Defra, 2019), which sets out the Government's agenda with regard to air quality for the coming years. Some of the objective values are also laid out within the Air Quality (England) Regulations 2000 (as amended) and Air Quality (Wales) Regulations 2000.

The UK Air Quality Objectives are set for the purposes of Local Air Quality Management (LAQM) under the provisions of Part IV of the Environment Act 1995 and apply only at locations where there is public exposure to pollutants over the averaging timescales of the respective objectives.

The main air pollutants of concern with respect to human health in the majority of the UK are NO_2 and particulate matter (PM_{10} and $PM_{2.5}$). Road traffic and energy generation are typically the most important sources of these pollutants. Ecosystems may also be sensitive to the effects of nitrogen deposition and acidification due to nitrogen oxides. The AQS objectives for England and Wales for the pollutants relevant to the proposed activity are presented in Table 16-1.

Table 16-1 UK air quality strategy objectives

Pollutant	Legislation	Averaging period	Value	Maximum permitted exceedances
Nitrogen Dioxide (NO_2)	AQS objective	Annual Mean	40 µg/m^3	None
		Hourly Mean	200 µg/m^3	18 times per year
Nitrogen Oxides (NO_x)	AQS objective (for ecosystems)	Annual Mean	30 µg/m^3	None
Particulate Matter (PM_{10})	AQS objective	Annual Mean	40 µg/m^3	None
		24-hour Mean	50 µg/m^3	35 times per year
Fine Particulate Matter ($PM_{2.5}$)	AQS objective	Annual Mean	25 µg/m^3	Not applicable
		Annual Mean	Work towards reducing emissions/ concentrations	Not applicable

Local councils assess air quality within their areas as part of the Local Air Quality Management (LAQM) Review and Assessment regime. The purpose of the LAQM regime is to identify areas in which exposure to air pollution breaches the National Air Quality Objectives and declare Air Quality Management Areas (AQMAs) where breaches of the objectives are determined.

Generally, air quality around Bedwyn Sands and NMG appears to be good, apart from some of the urban areas in relative proximity to the Licence Renewal Areas, for which AQMAs have been declared. There are no AQMAs that overlap with the Licence Renewal Areas; the closest AQMAs are located more than 5 km away in Bristol, Newport and Cardiff (Defra AQMA Interactive Map[14]). These AQMAs are related to exceeding thresholds of nitrogen dioxide (NO_2), with Bristol AQMA also exceeding thresholds for particulate matter (PM_{10}).

In line with Defra's 'Air quality plan for nitrogen dioxide (NO_2) in UK (2017)', Air Quality Plans have been developed in nearby urban areas to monitor and control levels of NO_2, including the Cardiff Urban Area and Bristol Urban Area (UK0026 and UK0009, respectively) where thresholds have been exceeded (Defra, 2017a and 2017b; Defra, 2022). These plans reference road traffic sources as being the main source of NO_2 pollution. Hence, it is anticipated that the aggregate dredging operations at Bedwyn Sands and NMG Renewal Areas, which are ongoing and not expected to increase in intensity, will not significantly impact NO_2 levels in the area.

16.2.1 Shipping and marine aggregates

Most international shipping uses low grade residual fuel which generates carbon dioxide (CO_2), nitrogen oxides (NO_x) and sulphur oxides (SO_x), all of which are greenhouse gases. The European Directive 2005/33/EC as regards the sulphur content of marine fuel has changed the fuel oil sulphur controls for ships in order to improve air quality near ports. Under the Directive, the maximum allowable sulphur content of fuel oil used by ships at berth in EU ports is 0.1% (Article 4b). Dredging vessels in the UK marine aggregate industry use Marine Diesel Oil (MDO) or Marine Gas Oil (MGO) which are distillate fuels with lower sulphur content than residual fuel, and hence marine aggregate vessels will generate lower SO_x emissions than from comparably sized vessels using residual fuel (Lloyd Jones *et al.*, 2010).

The Crown Estate (2010) commissioned a study to investigate the current carbon footprint of the extraction of marine aggregates from seabed areas surrounding England and Wales. The report

14 Defra AQMA Interactive Map: https://uk-air.defra.gov.uk/aqma/maps/ (Accessed July 2023)

concluded that total CO_2 emissions for vessels with a loading capacity <3,000 tonnes is 6.41 kg/t, compared to 11.73 kg/t for vessels with >3,000 tonnes capacity (Table 16-2).

The dredger expected for use at Bedwyn Sands and NMG Licence Renewal Areas has a load capacity of approximately 1,100 tonnes (i.e. a small vessel). Results presented in Table 16-2 indicate that the majority of CO_2 emissions are related to the vessel's transit to and from the aggregate extraction site (49% for small vessels and 53% for large vessels).

Table 16-2 Carbon footprint summary of marine aggregate dredging operations

Dredging Activity	Small Vessels		Large Vessels	
	kg CO_2 Per Tonne Landed	%	kg CO_2 Per Tonne Landed	%
Prospecting and monitoring	0.05	1	0.06	1
Capital burdens	0.49	8	0.55	5
Transit	3.17	49	6.20	53
Loading/dredging	0.81	13	1.55	13
Discharge	0.98	15	1.14	10
Wharves	0.92	14	2.23	19
Total	**6.41**	**100**	**11.73**	**100**

Source: The Crown Estate, 2010

Similarly, Table 16-3 shows the amount of CO_2 emitted in relation to marine aggregate production by the British Marine Aggregate Producers Association (BMAPA) fleet between 2016 and 2020. The dredger proposed for use at Bedwyn Sands and NMG Licence Renewal Areas is not part of the BMAPA fleet, however, the information presented in Table 16-3 provides a comparison to assess typical carbon emissions from dredgers during marine aggregate extraction operations. This demonstrates that total CO_2 emissions from the BMAPA fleet have generally declined in this timeframe. While reported marine aggregate production reduced by 17.2% during 2020, the corresponding reductions in total fuel oil consumption and CO_2 emissions reported by BMAPA operators were only around 9%. This can be explained because although several vessels were laid up during the second quarter of 2022, they remained under power. Meanwhile the vessels that remained operational were having to supply a wider range of markets, necessitating longer steaming times (BMAPA, 2022).

Table 16-3 Carbon dioxide (CO_2) emissions in relation to aggregate production

Emissions	2020	% Change	2019	2018	2017	2016
Total CO_2	81,355 t	-9.5%	89,890 t	90,120 t	94,614 t	95,384 t
Marine aggregate production	10.6 Mt	-17.2%	12.8 Mt	12.6 Mt	13.6 Mt	13.5 Mt
CO_2 per tonne landed	7.65 kg/t	+9.1%	7.01 kg/t	7.15 kg/t	6.96 kg/t	7.06 kg/t

Source: BMAPA, 2022

Previous reports (e.g. BMAPA, 2014) specified the typical emissions for smaller versus larger dredgers. For example, in 2014, when 7.46 kg CO_2/t were estimated to have been emitted per tonne landed, it was specified that, for smaller dredgers (< 3,000 t), average values of 4.61 kg CO_2/t would be assumed, and 8.14 kg CO_2/t for larger dredgers (>3,000 t). Hence, smaller vessels are more efficient in terms of CO_2 emissions per tonne of aggregate landed compared to larger vessels.

16.3 Impact assessment

This section considers the potential changes to the baseline air quality conditions which may be brought about by aggregate dredging activity in Bedwyn Sands and NMG Licence Renewal Areas. Dredging in the Licence Renewal Areas has the potential to affect air quality through the following activities and sources:

- **Vessel Presence**: Potential for marine aggregate dredger emissions to affect air quality receptors.

Impact pathways not included in the assessment: No pathways have been scoped out of this assessment.

Impact pathways included in the assessment: The key impact pathway relating to air quality is the following:

- Potential for Change in Air Quality Due to Aggregate Dredger Emissions (Section 16.3.1).

16.3.1 Potential for changes in air quality due to aggregate dredger emissions

General scientific context

The licence to dredge for marine aggregates at Bedwyn Sands and NMG will (continue to) result in CO_2 emissions, as well as other greenhouse gas (GHG) emissions. The total annual maximum and mean air emissions resulting from the proposed marine aggregate operations have been estimated based on existing data on CO_2 emitted per tonne dredged (see Table 16-4). A conservative approach has been taken, selecting the largest carbon emission scenario using values for small vessels from The Crown Estate (2010) (6.4 kg/t).

Over the fifteen-year licence period, a total of 48,076 tonnes of CO_2 is estimated to be produced as a result of the operation of the dredger in both Licence Renewal Areas. Average/typical annual extraction is expected to lead to 1,314 tonnes of CO_2 across both Areas (Table 16.4).

Table 16-4 Estimated carbon dioxide emissions at Bedwyn Sands and NMG Licence Renewal Areas

Site	Licence Period (Years)	Total CO_2 Emissions (Tonnes)	Maximum Annual CO_2 Emissions (Tonnes)	Typical Annual CO_2 Emissions (Tonnes)
Bedwyn Sands	15	24,038	1,603	224
North Middle Ground	15	24,038	1,603	1,090
Estimates are based on maximum CO_2 emissions per tonne landed provided in Table 16-2 and the proposed/anticipated extraction volumes in Table 3-2.				

Impact assessment

Aggregate extraction from Bedwyn Sands and NMG is not expected to change the type and number of shipping movements in the wider study area given that the activity is ongoing and not expected to increase in intensity. Furthermore, the nearest sensitive human receptors are on the northern coast of the Severn Estuary, approximately 2 km north of the Licence Renewal Areas.

It should also be noted that marine aggregates extraction may provide an environmental advantage compared to the extraction of aggregates on land, in terms of reduced lorry miles, with associated reductions in CO_2 emissions.

The exposure to change is considered negligible, as the magnitude of change is negligible due to the application being a renewal of dredging activity (as opposed to a new licence). This leads to no vulnerability, despite potentially moderate sensitivity of air quality receptors. Therefore, the overall impact of dredging in Bedwyn Sands and NMG Licence Renewal Areas on air quality is considered to be **insignificant**.

16.4 Summary and conclusions

Table 16-5 summarises the impact assessment judgements, presents final conclusions on overall impacts across all impact pathways, and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 16-5 Air quality impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, it is considered that the impact pathway associated with air quality has a negligible exposure to change.
Estimation of vulnerability	Based on the evidence in this assessment, it is estimated that the vulnerability of features potentially impacted by air quality is none.
Estimation of significance	Considering evidence presented in this assessment on the importance of features potentially impacted by air quality, the estimation of significance is insignificant assuming a 15-year maximum extraction scenario.
Conclusion	The anticipated air emissions resulting from the proposed marine aggregate operations have been estimated. The assessment has concluded that overall, the impact on existing air quality is considered to be **insignificant** and will not require any mitigation.
Confidence Assessment	The data on which this assessment is based uses conservative assumptions and also there is a 2 km distance from the nearest sensitive receptor. Confidence in the assessment is **high**.

16.5 References

British Marine Aggregate Producers Association (BMAPA) (2014) Strength from the Depths. Eighth Sustainable Development Report for the British Marine Aggregate Industry. December 2014.

British Marine Aggregate Producers Association (BMAPA) (2022) S BMAPA Sustainable Development 2020/2021. BMAPA, London, 12p.

Department for Environment, Food and Rural Affairs (Defra) (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Defra, London, 56p.

Defra (2017a) Air Quality Plan for tackling roadside nitrogen dioxide concentrations in Cardiff Urban Area (UK0026). Department for Transport. [Online] Available at: https://uk-air.defra.gov.uk/assets/documents/no2ten/2017-zone-plans/AQplans_UK0026.pdf [Accessed September 2023].

Defra (2017b) Air Quality Plan for tackling roadside nitrogen dioxide concentrations in Bristol Urban Area (UK0009). Department for Transport. [Online] Available at: https://uk-air.defra.gov.uk/assets/documents/no2ten/2017-zone-plans/AQplans_UK0009.pdf [Accessed September 2023].

Defra (2019) A Clean Air Strategy 2019. [Online] Available at: https://www.gov.uk/government/publications/clean-air-strategy-2019 [Accessed September 2023].

Defra (2022) Air Quality Management Area (AQMA) Interactive Map. [Online] Available at: AQMAs interactive map (defra.gov.uk) [Accessed September 2023].

Lloyd Jones, D., van Rhee, C. and Gibbs, T. (2010) Mitigation of Marine Aggregate Dredging Impacts - Benchmarking Equipment, Practices and Technologies Against Global Best Practice. Emu Ltd, Southampton, 168p.

The Crown Estate (2010) Marine Estate Research Report. Carbon Footprint of Marine Aggregate Extraction. Prepared by Environmental Resources Management Limited. July 2010.

17 Infrastructure and Other Existing Marine Users

This section reviews the effects of the proposed activity at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on infrastructure and other marine user receptors. Section 17.1 outlines the data sources and organisations/stakeholders consulted to inform the baseline and assessment. Baseline information is provided in Section 17.2 before an impact assessment is given in Section 17.3. Section 17.4 contains a brief conclusion. This section excludes Commercial and Recreational Fisheries, which is discussed separately in Section 12. Reference should also be made to Section 13 for Commercial and Recreational Navigation.

A definition of the study areas applied in this ES is provided in Section 4.1. For the purposes of this assessment, the wider study area relates to the Severn Estuary as a whole but focuses on a buffer of approximately 10 km from the Licence Renewal Area (as shown in Figure 17-1).

17.1 Data sources and consultation

17.1.1 Data sources

The following datalayers and reports helped inform the baseline for this section:

- Relevant GIS datalayers;
- Wales Marine Planning Portal;
- The Severn Estuary Partnership website; and
- Sources quoted in cross-referenced ES sections.

17.1.2 Consultation

Table A-1 and Table A-2 in Appendix A summarise the aspects raised during the scoping review, and where and how these were addressed. With regard to infrastructure and other marine users receptors, no comments were made in the formal responses.

17.2 Review of baseline understanding

The nearest infrastructure and other marine users are shown in Figure 17-1 and described below:

- Cables and pipelines – there are no subsea cables or pipelines within 10 km of the Licence Renewal Areas. Several pipelines are located in the intertidal zone near Avonmouth, Redwick, and Newport (see Figure 17-1). These pipelines are all over 3 km away from the Bedwyn Sands and NMG.
- Disposal sites – there are seven disposal sites within 5 km of the Licence Renewal Areas, the nearest of which is LU100, over 1 km from Bedwyn Sands and NMG.
- Aggregate areas – the closest aggregate area to Bedwyn Sands and NMG is Area 531, which is approximately 4 km from NMG. Area 531 is licensed until 2037 for aggregate dredging and has an annual maximum tonnage of 30,000.
- Military Practice Areas – a Ministry of Defence firing range is approximately 1 km north of Bedwyn Sands.

- Tourism is one of the largest services industries around the estuary (Severn Estuary Partnership, 2022), although the combination of high tidal range, strong currents and high levels of turbidity limits the amount of recreational water use in the Severn Estuary (Thomson, 2007). Activities within the wider study area include bird watching, wildfowling and walking (Department of Energy and Climate Change (DECC), 2010; Severn Estuary Partnership, 2022). Please note that recreational navigation is addressed under Section 13.

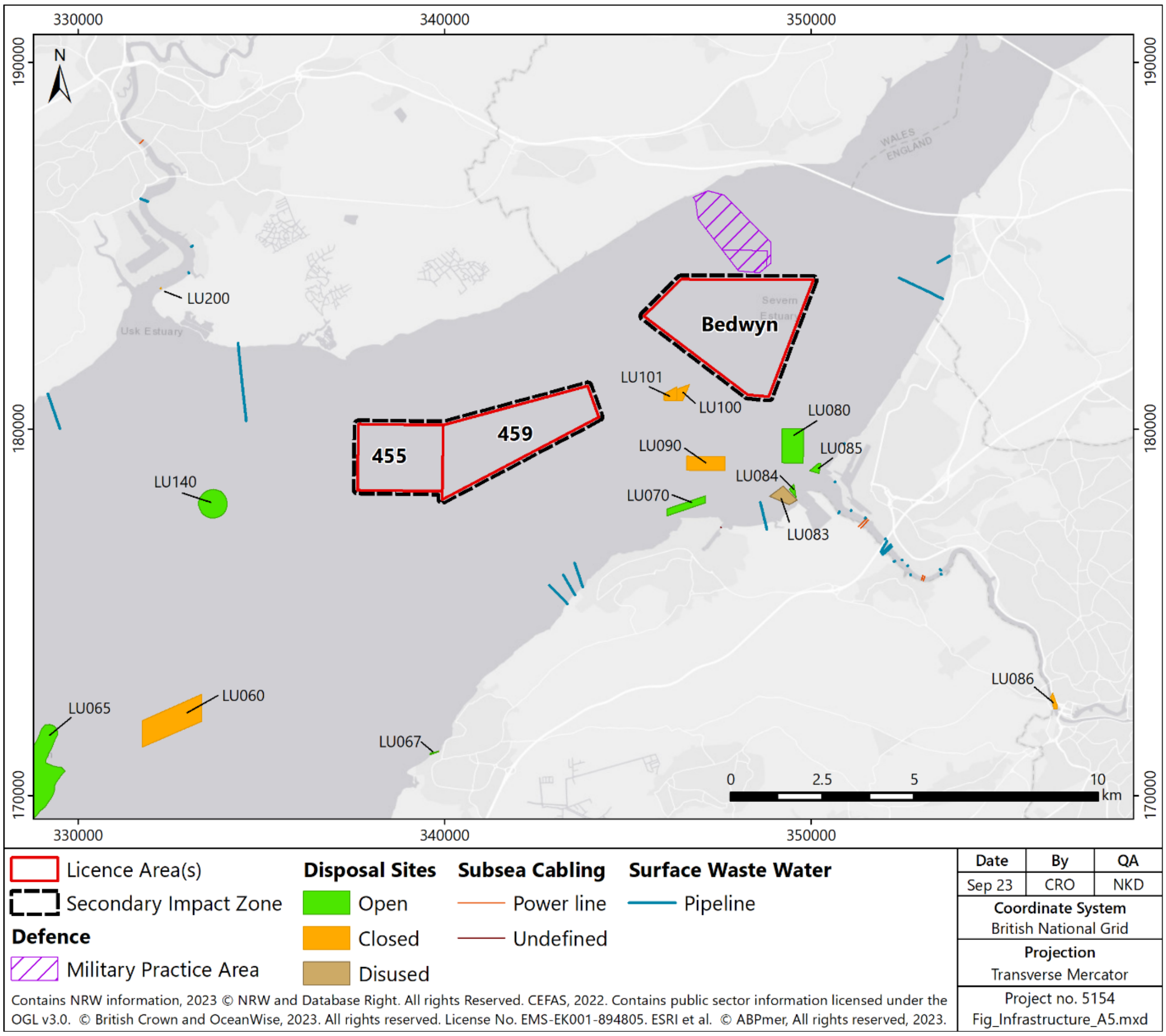

Figure 17-1 Infrastructure and other marine users in study area

17.3 Impact assessment

The Licence Renewal Areas have the potential to affect infrastructure and other users through the following activities and sources:

- **Draghead** – The removal of substratum leading to scouring on the seabed floor could potentially damage both submarine and land-based infrastructure.
- **Overspill –** Increases in turbidity and subsequent sedimentation could potentially impact upon recreational marine users.
- **Screening** – This will result in the same, albeit more localised, effects as the overspill (see above); and

- **Vessel presence** – The presence of the dredger may cause a disturbance and displace other vessels. An additional potential disturbance is increase in noise and vibration levels which could potentially disturb marine users.

Impact pathways not included in the assessment: No spatial overlap with any infrastructure or other marine users is identified and therefore seabed removal and noise and vibration is scoped out of the assessment.

Impact pathways included in the assessment: The key impact pathway relating to marine infrastructure and other users are addressed in the following sections:

- Potential impacts of physical processes changes on marine and land-based infrastructure (Section 17.3.1).

Potential impacts relating to recreational fishing are covered in Section 12. Vessel displacement and the safety of users are also covered in Section 13 (Commercial and Recreational Navigation).

17.3.1 Potential impacts of physical processes changes on marine and land-based infrastructure and other marine users

General context

Significant changes in peak tidal current speeds in the Licence Renewal Areas could impact on marine infrastructure, such as disposal sites and aggregate extraction areas due to scour or deposition of existing or introduced material. Coastal (land-based) infrastructure could also be affected by changes in wave condition and beach drawdown.

As discussed in Section 5 (Physical Processes), changes in tidal currents and wave climate are predicted to be very localised to within/near Bedwyn Sands and NMG and are not generally considered significant at that scale. The potential impact zones of sediment plumes and fine sediment dispersal/bedform are not predicted to extend beyond 500 m of the Licence Renewal Areas (i.e. will be contained within the SIZ) (see Section 4.1).

Impact assessment

No significant impacts on the coast were predicted in Section 5.4 with regard to changes to tidal currents, waves and beach drawdown, hence there is a negligible exposure to change for the land-based infrastructure receptors. Similarly, for marine infrastructure, all of the recorded locations are a substantial distance from the study area and will therefore not be affected by any potential changes.

It should be noted that the proposed activity is already ongoing and that average levels of activity are not predicted to increase. Given this and other aspects noted above, marine and land-based infrastructure and other marine users are subject to a negligible exposure to change and impacts on all these receptors are therefore considered to be **insignificant**.

17.4 Summary and conclusions

Table 17-1 summarises the impact assessment judgements, presents the final conclusions on overall impacts across all impact pathways and also provides an indication of the confidence in the respective assessments and evidence base.

The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 17-1 Infrastructure and other marine users impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment it is considered that the impact pathways associated with marine and land-based infrastructure and other marine users are subject to a negligible exposure to change.
Estimation of vulnerability	It is estimated that the vulnerability of marine and land-based infrastructure and other users is none.
Estimation of significance	Considering the evidence presented in this assessment, the importance of features potentially impacted by dredging in Bedwyn Sands and NMG is low to high. However, due to a negligible exposure, impacts on all infrastructure receptors and other marine users are considered to be insignificant.
Conclusion	Whilst there is marine and coastal infrastructure within the wider study area these are all sufficiently distant to not be affected. No impacts on the coast were predicted by the coastal processes assessment (see Section 5). In addition, the proposed activity is already ongoing and activity levels are not predicted to increase. The assessment has concluded that overall, the impact to marine and land-based infrastructure and other marine users will be **insignificant** and will not require mitigation.
Confidence Assessment	The data on which this assessment is based uses conservative assumptions. Confidence in the assessment is **high**. This is based on a high confidence in the spatial data, and also a high confidence in the physical processes assessment (Section 5, which much of this assessment was based on.

17.5 References

Department of Energy and Climate Change (DECC) (2010) Severn Tidal Power – SEA Topic Paper Other Sea Users.

Severn Estuary Partnership (2022) [Online] Available at: http://www.severnestuary.net [Accessed September 2023].

Thomson, S. (2007) Identifying recreational cruising routes, sailing and racing areas within the SEA 8 Area. A report for the Department of Trade and Industry by the Royal Yachting Association.

18 Human Health

This section assesses the effects of the proposed dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) on human health receptors. Section 18.1 outlines the data sources and organisations/stakeholders consulted to inform the baseline and assessment.

Sections 18.2 and 18.3 cover the baseline and impact assessment relating to nature conservation, respectively and Section 18.4 provides a brief conclusion.

18.1 Data sources and consultation

18.1.1 Data sources

The principal data sources consulted in this assessment are as follows:

- The Office of National Statistics 2021 Census and 2011 Census;
- Somerset County Council (SCC) (2013) Health and Wellbeing Strategy; and
- Well Being of Future Generations (Wales) Act 2015.

18.1.2 Consultation

Table A-1and Table A-2in Appendix A summarise the aspects raised during the scoping review, and where and how these were addressed. With regard to human health receptors, no comments were made in the formal responses.

18.2 Review of baseline understanding

18.2.1 National baseline

Information on the general health and well-being of the English and Welsh population can be drawn from several Community Health Indicators obtained in the 2021 Census. One of these indicators uses the percentage of household residents who reported their health over the previous 12 months as having been "not good". Evidence suggests that this self-reported measure of health has good predictive validity of mortality and health care utilisation. Another indicator presented is the percentage of the household residents with a limiting long-term illness, based on answers to the question: " Do you have any physical or mental health conditions or illnesses lasting or expected to last 12 months or more?". Life expectancy over the period 2018-2020 is also included.

Table 18-1 shows selected health indicators for England and Wales. In England, 18.3% of people described their health for the 12 months prior to Census day (21 March 2022) as “not good” and in Wales, 20.8%. The proportion of people with a limiting long-term illness showed a similar trend, with a lower proportion in England than in Wales. Life expectancy has increased since 2011 for both males and females, with life expectancy higher in females than males.

Table 18-1 Health indicators in 2021 and changes in life expectancy since 2011

Area	Health 'Not Good' (%)[1]	Limiting Long-term Illness (%)[2]	Life Expectancy at Birth[3] (Years)	
			Male	Female
England	18.3	17.7	82.6 (78.9)	86.1 (82.9)
Wales	20.8	21.1	81.6 (78.0)	85.2 (82.2)

Notes: Figures for 2001 shown in brackets.

1. Includes the categories: fair health, bad health and very bad health (ONS 2023a). General health refers to health over the 12 months prior to Census day (21 March 2021).
2. Includes any health problem or disability (including problems related to old age) which has lasted or is expected to last for at least 12 months and limits day-to-day activities a little or a lot (ONS, 2023b).
3. Life expectancy for the period 2018-2020 (ONS, 2021). Percentage change in life expectancy since 2009-2011 shown in brackets.

Source: ONS, 2023

18.2.2 Regional baseline

Further insights into the health of people living in the Bristol Channel and Severn Estuary region can be obtained from the Offshore Energy's Strategic Environmental Assessment (Department for Business, Energy & Industrial Strategy (BEIS), 2016), which divided the UK's coastal stretches into a series of 'Regional Seas'. The wider study area for this EIA is incorporated in 'Regional Sea 4', which incorporates the length of coast from South Hams, Devon on the south coast of England to Pembrokeshire in southwest Wales. The report by BEIS (2016) was based on the 2011 Census and, whilst the 2021 Census was published January 2023, no updated regional assessments have been published. However, the regional values from 2011 are used below and provide a useful indication of approximate population size and employment structure in the area.

In 2011, the total population of Local Authority Districts and Unitary Authorities along the English and Welsh coasts in Region Sea 4 was 3,681,000 which an overall density of 238 persons/km^2. Population density in the region was generally low, below that of both England and the UK as a whole, although above that of Wales. The Inner Bristol Channel area sees higher population densities around Bristol and Cardiff (4,022 and 2,531 persons/km^2, respectively), with slightly higher densities along much of the south Wales Coast as far as Swansea (635 persons/km^2).

Employment structure is considered to be very similar to the UK as a whole for Regional Sea 4, although considerable variation is observed between individual areas. Many areas show a higher contribution to agriculture than the UK Average; particularly West Somerset (5.6%) and Pembrokeshire (4.7%). Contributions to the industrial sector are greatest in the south Wales area of Neath Port Talbot (25.4%) and Bridgend (23.7%), while the service sector is the most dominant in urban areas such as Cardiff (86.6) and Bristol (85.7).

18.2.3 Guidance and legislation

England and Wales both have national legislation in place to promote human health and wellbeing. In Wales, the Well-being of Future Generations (Wales) Act 2015 aims to uphold and promote sustainable development and well-being by ensuring that public bodies consider long term effects and work effectively with communities and other relevant public bodies. This Act put in place seven well-being goals which are outlined in Table 18.2.

Table 18-2 Descriptions of the seven wellbeing goals of the Well Being of Future Generations (Wales) Act 2015

Goal	Description of goal
A prosperous Wales	An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work.
A resilient Wales	A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).
A healthier Wales	A society in which people's physical and mental well-being is maximised and in which choices and behaviours that benefit future health are understood.
A more equal Wales	A society that enables people to fulfil their potential no matter what their background or circumstances (including their socio economic background and circumstances).
A Wales of cohesive communities	Attractive, viable, safe and well-connected communities.
A Wales of vibrant culture and thriving Welsh language	A society that promotes and protects culture, heritage and the Welsh language, and which encourages people to participate in the arts, and sports and recreation.
A globally responsible Wales	A globally responsible Wales. A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global wellbeing and the capacity to adapt to change (for example climate change).

NRW is one of the public bodies legally bound to the Well Being of Future Generations (Wales) Act 2015 (Welsh Government, 2016) and is the body most relevant to this assessment. They are responsible for protecting and improving people's health and well-being as well as assuring the natural resources of Wales are sustainably maintained, enhanced and used, now and in the future (NRW, 2016). NRW work with organisations and local communities to contribute to the sustainable development goals for Wales and apply the principles set out in the Act. Several objectives have been set by NRW to assist them in achieving their objectives; these are to (NRW, 2015):

- Provide and enable recreation and access opportunities which contribute to improving people's health and wellbeing (healthier Wales and vibrant culture goals);
- Help ensure people are able to live, work in, and visit a good quality environment, including those in urban areas and those in our most disadvantaged communities, and will channel economic benefit to help tackle poverty (prosperous Wales and cohesive communities goals);
- Provide and enable opportunities for people to learn in, and about, and enjoy the environment (prosperous Wales and more equal Wales goals); and
- Deliver an effective and co-ordinated response to environmental incidents and risks, such as flood events, pollution and disease outbreak, and help decrease the risk of flooding to people and properties (resilient Wales goal).

In England, the Health and Social Care Act 2012 led to the establishment of Health and Wellbeing Boards at county council level. These are forums designed to produce an understanding of the needs of local communities, and to improve the overall health and wellbeing.

The Somerset Health and Wellbeing Board cover the area of coast adjacent to the Inner Bristol Channel. It has developed a Health and Wellbeing Strategy for Somerset which identifies three themes (SCC, 2013):

- Theme 1: People, families and communities take responsibility for their own health and wellbeing;
- Theme 2: Families and communities are thriving and resilient; and
- Theme 3: Somerset people are able to live independently.

Theme 1 is the only theme that takes into account of the effect of the surrounding environment, with one priority under the theme defined as (SCC, 2013):

> *"The Health and Wellbeing Board will ensure that health and wellbeing is given due consideration in planning and other policy decisions to maximise the positive impact of our environment on healthy lifestyles."*

18.3 Impact assessment

This section considers the potential changes to the baseline conditions which may be brought about by aggregate extraction from Bedwyn Sands and NMG Licence Renewal Areas. Dredging in in these areas has the potential to affect Human Health through the following activities and sources:

- **Vessel Presence**: Potential for marine aggregate dredger emissions to affect human health receptors;
- **Transport of landed aggregates**: Potential for emissions from vehicles transporting landed aggregates to affect human health receptors;
- **Noise and Visual Disturbance**: Disturbance to human beings caused by visual and noise stimuli from vessels and machinery.

Impact pathways not included in the assessment: All identified impacts pathways relating to human health have been taken forward in this assessment. More indirect pathways have not been taken forward, e.g. related to the positive economic impacts from providing employment at the wharves or enabling construction activities.

Impact pathways included in the assessment: The key impact pathway relating to human health is the following:

- Potential impacts on human health related to air quality and noise/light pollution (Section 18.3.1).

18.3.1 Potential impacts on human health related to air quality and noise/light pollution

General scientific context

Marine aggregate dredging has the potential to have visual impacts on humans through the presence of the dredger at Bedwyn Sands and NMG, and transit to and from ports. Dredging could also affect human health through impacts on air quality from both ship based and land-based transport. Noise and light pollution could also occur.

Impact assessment

Several of the pathways listed in the preceding paragraph have previously been excluded from the EIA for the proposed marine aggregate dredging at Bedwyn Sands and NMG Licence Renewal Areas, and are thus insignificant (see Table 4-2/Section 4.2). This includes land-based traffic impacts, given that the marine aggregates dredged in the Severn Estuary are used as landed (i.e. 'delivered' at the wharves), and not further processed on shore.

With regard to noise, it was concluded that, given the distance from the nearest sensitive receptors (over 2 km, as specified above), and the existing level of aggregate extraction in the area, there was no impact pathway for humans to be disturbed by noise.

It is also worth noting that the proposed activity is already ongoing, and that average levels of activity or shipping are not predicted to increase. Dredgers would frequent established ports and wharves, as per current dredging activities, and thus utilise existing transit routes. Considering evidence presented in this assessment, exposure to change is negligible. Thus, whilst the importance of human health is considered to be high, the estimation of significance is **insignificant** assuming a 15-year maximum extraction scenario.

18.4 Summary and conclusions

Table 18-3 summarises the impact assessment judgements, presents final conclusions on overall impacts across all impact pathways, and also provides an indication of the confidence in the respective assessments and evidence base. The impact assessment methodology (Section 4.4) provides an explanation of the iterative assessment process, including tables explaining how exposure, vulnerability and finally significance are assessed.

Table 18-3 Human health impact assessment summary and conclusions

Assessment	Summary
Exposure to change	Based on the evidence in this assessment, it is considered that the impact pathway associated with human health has a **negligible** exposure to change.
Estimation of vulnerability	Based on the evidence in this assessment, it is estimated that the vulnerability of features potentially impacting human health is **none**.
Estimation of significance	Considering evidence presented in this assessment whilst the importance of human health is considered to be high, the estimation of significance is **insignificant** assuming a 15-year maximum extraction scenario.
Conclusion	The anticipated human health resulting from the proposed marine aggregate operations through various pathways have been estimated. The assessment has concluded that overall, the impact on human health is considered to be **insignificant** and will not require any mitigation.
Confidence Assessment	The data on which this assessment is based uses conservative assumptions and also there is a 2 km distance from the nearest sensitive receptors. Confidence in the assessment is high.

18.5 References

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19 Cumulative and In-Combination Effects

Dredging will potentially occur within the Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459) at the same time as other activities and plans or projects. The majority of the activities being considered are already occurring within the wider study area. All activities and plans have the potential to result in additional impacts on the same receptors as the continued dredging activity, resulting in a cumulative and/or in-combination impact.

Industry standards for conducting cumulative and in-combination impact assessments include a guidance note published by the MMO (2014) and the CIA framework for MPAs work (NECR174) (Natural England, 2014). This section considers that a cumulative/in-combination assessment needs to take account of the total effects of all pressures acting upon all relevant receptors in seeking to assess the overall cumulative/in-combination significance.

Additionally, consideration is given to any other activities and plans or projects, including any impacts that do not directly overlap spatially, but may indirectly result in a cumulative/in-combination impact. By looking at all potential impacts, the information provided in this section therefore addresses the requirement under the EIA Regulations and also informs the assessment of in-combination impacts in line with the requirements of the Habitats Regulations under one assessment.

The Marine Works (EIA) Regulations 2007 (as amended) specifically refer to 'cumulative' effects, while the Habitats Regulations refer to 'in-combination' effects. However, in practice, both need to be interpreted as referring to cumulative and in-combination effects because the assessments, whether for EIA or for HRA, need to understand the combined influence of all environmental pressures acting upon the relevant receptors in seeking to assess the significance of environmental effects.

On this basis, the main difference between the cumulative assessment for EIA and the in-combination assessment for HRA is the range of receptors included in the assessment. For the purposes of this ES, the range of features needs to cover both environmental receptors (including protected interest features) and other human activities and interests that might be affected, while the HRA focuses solely on the relevant features potentially affected within internationally designated sites that have been screened into the assessment.

It is worth noting that the BMAPA glossary (BMAPA, 2010) defines cumulative impacts as 'additive impacts resulting from dredging at more than one site', and views in-combination 'additive' impacts which result 'from marine aggregate dredging and other marine activities such as fishing, shipping etc'.

Section 19.1 below provides a definition of the study areas for the cumulative and in-combination assessment. Section 19.2 then presents the data sources that have been consulted and the consultation which has taken place. Section 19.3 describes the baseline conditions of the study area in terms of extant projects in the planning system and ongoing activities. The cumulative and/or in-combination effects associated with the proposed works alone and/or in-combination effects associated with other projects, plans and activities are presented in Section 19.4.

19.1 Study areas

The study area is the area over which potential direct and indirect cumulative effects of the proposed activity alone or in-combination with other plans, projects and activities may occur during construction and operation. The study area is, therefore, defined as the spatio-temporal coverage of all the potential effects associated with the proposed development that have been assessed in this ES, together with the area covered by interest features of overlapping and nearby international sites that have been screened into the HRA.

For the purposes of this assessment, the 'immediate study area' comprises both the footprint of the licence applications for Bedwyn Sands and NMG (coinciding with the PIZ) and the potential SIZs, as are represented by a 500 m buffer around the dredging areas. The 'wider study area' comprises the Severn Estuary. For marine mammal receptors, a larger study area was applied due to their highly mobile nature, though, for proportionality purposes, this was restricted to the Bristol Channel.

19.2 Data sources and consultation

19.2.1 Data sources

The principal data sources consulted in this assessment are as follows:

- NMG and Bedwyn Sands Coastal Impact Study (CIS) (ABPmer, 2023);
- Severn Estuary Shoreline Management Plan (SMP); and
- Relevant documents/ESs for the projects, plans and activities assessed.

19.2.2 Consultation

Table A-1 and Table A-2 in Appendix A summarise the aspects raised during the scoping review, and where and how these were addressed.

With regard to cumulative and/or in-combination impacts, the scoping opinions summarised the key aspects which would need to be considered, the types of projects that should be included in such an assessment, and the potential sources of information regarding other projects.

19.3 Review of baseline understanding

Based on consultation with relevant stakeholders, there are a number of extant projects in the planning system as well as ongoing activities and plans that have been identified as potentially having cumulative and/or in-combination impacts with dredging at Bedwyn Sands and NMG. These have been mapped and are shown in Figure 19-1. In summary, the plans, projects and activities that have been considered in this assessment are as follows (in no particular order):

- Other aggregate Licence Areas – the nearest Licence Area (Area 531) is 4 km of Bedwyn Sands and NMG. There are two other Licence Areas over 20 km from Bedwyn Sands and NMG (see Section 19.3.1);
- Bristol Deep Sea Container Terminal (BDSCT) at Avonmouth (TBPC, 2023) – 3.1 km from Bedwyn Sands and 6.9 km from NMG. This project plans to construct three 400 m berths dredged to a depth of 18 m; includes capital dredge to -14 mCD between new terminal and the English Grounds. A new disposal site at Holm Deep (LU065, 2.6 km from Area 526) is to be used for non-reusable dredge spoil. The scheme is consented, but is not currently being pursued; it also includes a compensatory habitat creation scheme at Steart (32 km from Bedwyn Sands and NMG), which was separately consented but is also currently on hold;
- Bridgwater / River Parrett Barrier (Somerset Council, 2023) - 42 km from Bedwyn Sands and NMG. This project plans to construct a tidal surge barrier across the River Parrett, some 14 km upstream from the mouth of the Parrett near Bridgwater. Enabling works on this consented scheme have commenced and the construction of the project is due to be completed within around 4 to 6 years;

- Cables and pipelines - there are no cables or pipelines that overlap with Bedwyn Sands and NMG, but several pipelines in the wider study area which have already been considered in the assessment of infrastructure and other existing marine users (see Section 17);
- Commercial and recreational fishing – widespread throughout study area, though generally at low intensities (see Section 12);
- Disposal sites – there are several open disposal sites in the wider study area, the nearest of which is LU100 over 1 km from Bedwyn Sands and NMG (see Section 17); also Figure 19-1;
- Hinkley Point A, B and C (Office for Nuclear Generation, 2023) – located 33 km from Bedwyn Sands and NMG. Hinkley Point A and B are being decommissioned (B stopped generating power in 2022), and Hinkley Point C, the UK's first new nuclear plant in a generation, is under construction. First power is expected to be available in 2027. Marine works include cooling water intakes, dredging, a temporary jetty and flood defences. Dredging for the cooling water intake took place in 2018 and the temporary jetty has been installed;
- Military Practice Areas – General practice area and submarine exercise are located in the Inner Bristol Channel, but none overlap with Bedwyn Sands and NMG (with the nearest being 29 km south-west in the Inner Bristol Channel);
- Ports, navigation and shipping – incorporates all supporting infrastructure, in particular maintenance and capital dredge channels and anchorages. The Bristol Channel and Severn Estuary is an important shipping area with large ships from national and international destinations using the estuary's ports and anchorages; in the immediate study area shipping density is relatively low (see Section 13);
- Recreation and tourism – Activities taking place in the area include angling, sailing and other watersports, as well as bird watching and walking (see Sections 12 and 13);
- Severn Flood Risk Management Plan (FRMP) (Environment Agency, 2022 – This Plan sets out where and how to manage flood risk within the Severn River Basin District (RBD) to provide most benefit to communities and the environment. This second cycle Severn RBD FRMP covers the part of the Severn RBD that is in England. NRW is currently producing a separate FRMP to cover the whole of Wales;
- The Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project (ASEA, 2023) - 2.6 km from Bedwyn Sands and 6.5 km from NMG. This project focuses on helping to support the growth of the ASEA and protecting the existing communities from flooding. Due to by completed by 2027;
- Tidal Lagoon Cardiff (The Planning Inspectorate, 2023) - 14.8 km from Bedwyn Sands and 6.7 km from NMG. The scoping report for this planned tidal lagoon for Cardiff Bay was submitted in March 2015. The project is currently on hold;
- Tidal Lagoon Swansea Bay (The Planning Inspectorate, 2023) - 81 km from Bedwyn Sands and NMG. This planned 'nationally significant infrastructure project' (NSIP) is to construct a tidal lagoon generating station in Swansea Bay. The proposal was rejected on financial grounds in June 2018 by the UK government, but there is still potential for the continued development (Holistic Capital, 2018);
- West Somerset Lagoon (Tidal Engineering, 2023; The Planning Inspectorate, 2023) – 50.5 km from Bedwyn Sands and 40.8 km from NMG. This proposed tidal lagoon power scheme is located off the coast of West Somerset between Minehead and Watchet. The EIA and DCO process is anticipated to commence in soon. According to the Planning Inspectorate, a timetable has not yet been set for this project;
- Avon Power Station (The Planning Inspectorate, 2023) – 4.3 km from Bedwyn Sands and 10.0 km from NMG. The scoping report for this new gas fired power station was submitted in January 2015. The project is currently on hold;
- Seabank 3 combined cycle gas turbines (CCGT) (The Planning Inspectorate, 2023) – around 5 to 10 km from Bedwyn Sands and NMG. The scoping report for these two additional high efficiency CCGT was submitted in February 2013. The project is currently on hold;

- Cardiff Coastal Defence Scheme (Natural Resource Wales (NRW), 2023) – around 15 to 20 km from NMG and Bedwyn Sands. This project is to improve and extend coastal and fluvial defences in an area of Cardiff to the east of Cardiff Docks, adjacent to the Severn Estuary and Rhymney River; and
- Sudbrook coastal defence maintenance (NRW, 2023) - around 5 to 10 km from Bedwyn Sands and NMG. This project is to undertake maintenance work to existing coastal defence structure at Sudbrook in Monmouthshire. Works consist of masonry repair, reseating loose embankment and reinstatement or replacement of failed toe beams.

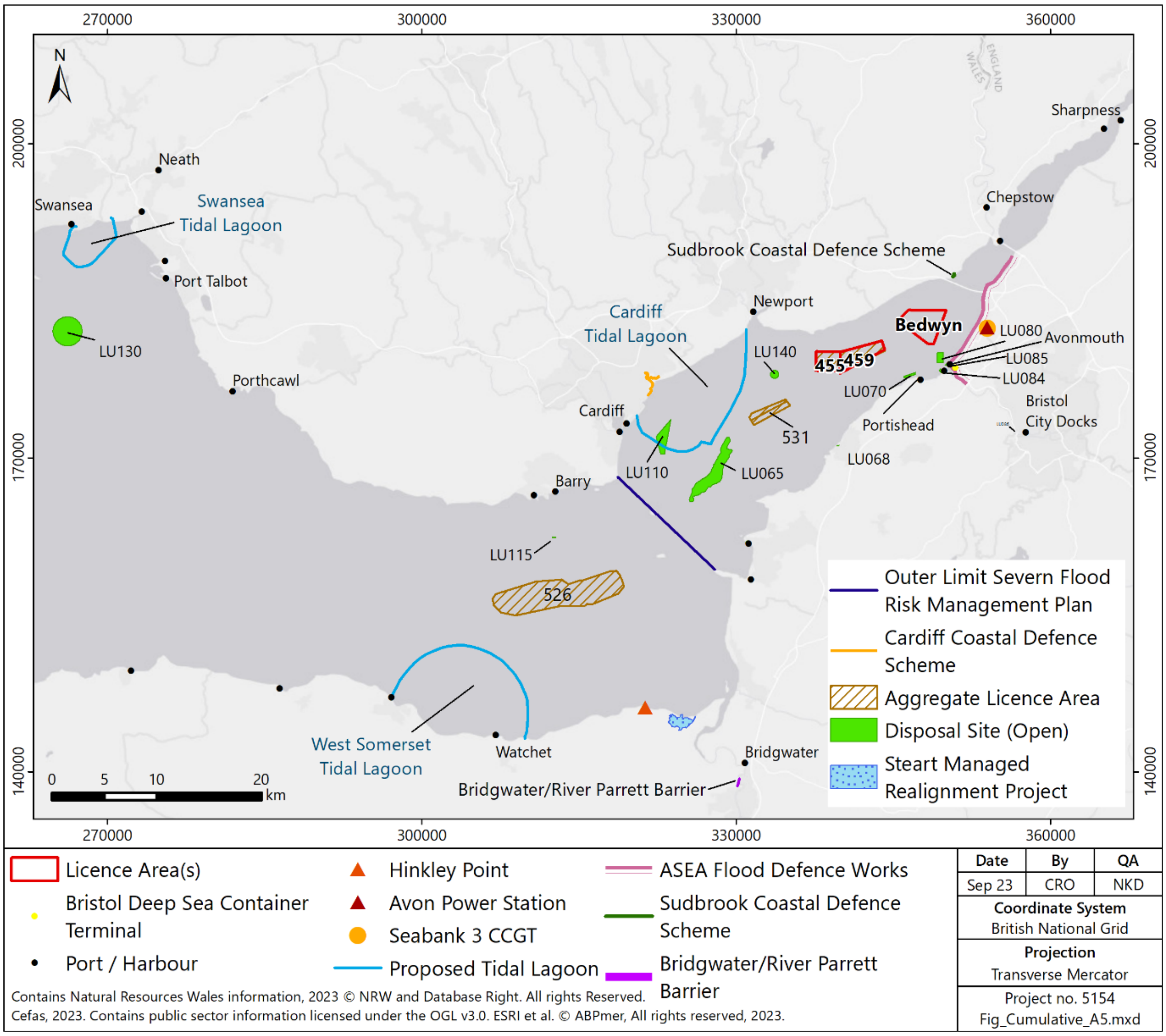

Figure 19-1 Other plans and projects in study area

Additional details on the stage in the planning process and potential impacts of some of these projects and activities are summarised in Table 19.1. More detail on aggregates dredging is provided in Section 19.3.1.

The following (non-dredging related) projects will not be considered further for the purpose of this cumulative and in-combination assessment, due to there either being no spatial and/or temporal overlap of potential effects (including indirect):

- Bridgwater / Parrett Tidal Barrier: due to the distances involved (and no apparent pathway overlap);
- Tidal Lagoon Swansea Bay: due to the distances involved (and no apparent pathway overlap), furthermore, all tidal lagoon projects in the Severn Estuary / Bristol Channel are currently on hold; and
- Tidal Lagoon Cardiff Bay: due to the project not being well defined, and a low likelihood of implementation in the near future;
- West Somerset Lagoon: due to the distances involved (and no apparent pathway overlap), furthermore, all tidal lagoon projects in the Severn Estuary / Bristol Channel are currently on hold;
- Avon Power Station: due to the project not being well defined, and a low likelihood of implementation in the near future;
- Seabank 3 CCGT: due to the project not being well defined, and a low likelihood of implementation in the near future; and
- Sudbrook coastal defence maintenance: due to the scale and nature of the project (and no apparent pathway overlap).

Due to an overlap with the Severn Estuary SPA, Ramsar and SAC sites, the following projects are considered in relation to the receptor groups which relate to the sites' features (i.e. benthic habitats, ornithology, fish ecology):

- Steart managed realignment scheme; and
- Hinkley Point C and B.

Table 19-1 Summary of plans and projects in the wider study area (excl. aggregates dredging)

Project	Stage in Planning Process	Potential Impacts
Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project	Planned coastal works between Aust and Avonmouth include raising existing flood banks, building new, higher concrete flood walls and building new, higher flood defences from steel sheet piles. Two ecology mitigation wetland areas (terrestrial) are also included. Planning permission was granted in March 2019 (Bristol Council, Ref 18/02847/FB). Under way, due to be completed in 2027.	An ES was produced in 2018 (CH2M, 2018). This project is therefore considered sufficiently well-defined to adequately quantify the scale of effects. No direct impacts on the Severn Estuary are predicted, as any increases in footprint are to landward of the defences. A small 1 ha area of saltmarsh is to be created by setting back defences. With regard to waterbirds, the creation of new waterbodies and wet grassland habitat is predicted to result in a significant positive effect for habitats and waterbird species on a local scale.
Bristol Deep Sea Container Terminal (BDSCT)	Consented in March 2010. Currently on hold. The Port of Bristol (Deep Sea Container Terminal) Harbour Revision Order 2010 initially expired in August 2020; an extension to August 2030 was applied for in 2016 and granted. Includes new terminal construction with reclaim, quay wall extension and capital dredge (up to 24 million m^3).	An ES was produced in 2008 (The Bristol Ports Company, 2008). This project is therefore considered sufficiently well-defined to adequately quantify the scale of effects.

Project	Stage in Planning Process	Potential Impacts
Hinkley Point C construction	ES produced and project consented, construction underway and first power is expected to be available in 2027. Dredging for the cooling water intake took place in 2018, with materials disposed at site LU110, and the temporary jetty has been installed. Further maintenance dredging is now underway, ahead of placement of the heads for the cooling water system (to be disposed of at Portishead licensed disposal site). EDF was seeking a permit variation to remove the previously proposed inclusion of an acoustic fish deterrent system from the cooling water system. The Environment Agency approved the changes in July 2023, pending approval by the Secretary of State for the Environment (Environment Agency, 2023).	The ES (EDF, 2011) specified that impacts are expected to occur from a number of stages, including site preparation works, the construction of a temporary jetty, the construction of a wharf and the main construction itself which will involve the creation of a seawall and cooling water intake and outfall structures. Most impacts are restricted to the immediate vicinity of the site; however, some impact such as construction discharge will impact the foreshore. Construction of the temporary jetty and wharf will be limited to the immediate vicinity of the jetty and the River Parrett. Construction of the main site, including the seawall will also only result in localised impacts. Operational impacts may extend into the Severn Estuary, including with regard to navigation.
Hinkley Point A and B decommissioning	Hinkley Point A ceased energy generation in 2000 and is currently undergoing decommissioning. Defueling and removal of most buildings is expected to take until 2031, followed by a care and maintenance phase from 2031 to 2085. Demolition of reactor buildings and final site clearance is planned for 2081 to 2091 (DECC & NDA, 2011). Hinkley Point B ceased generating energy in 2022 and is currently in the early phases of decommissioning, starting with defueling. The reactor building removal is anticipated for around 2105 onwards. The marine infrastructure would be removed in the next 10 to 15 years. It is proposed that the tunnels are left in place, but the intake and outfall structures removed. New outfalls for active waste discharges and potentially treated sewage would be installed, envisaged to reach the sea via the existing outfall tunnel.	Decommissioning of Point A has and will result in the discharge of gasses aqueous waste into the environment. However, future decommissioning work is not expected to have a significant impact on the marine environment. The only significant impacts expected are related to surface water resource and quality, economy, society and skills, and traffic and transport (Magnox, 2014). A scoping report for the decommissioning of Point B was submitted in 2022 (WSP, 2022); this highlighted the removal of the marine infrastructure as the key activity which could give rise to significant effects on marine biodiversity, chiefly through disturbance / degradation / loss of habitat, underwater noise impacts and / or discharges to water.

Project	Stage in Planning Process	Potential Impacts
Severn FRMP	The 1st cycle Severn RBD FRMP 2015 to 2021 was published in 2016 (Environment Agency, 2016) and the 2nd cycle (2021 to 2027) was published in 2022 (Environment Agency, 2022). Various sites were identified in the FRMP as potential for habitat creation around the estuary to offset intertidal and other habitat loss.	Over the past 10 years new coastal habitats such as Steart Marshes in Somerset have been created as part of the Environment Agency's ongoing habitat creation programme. Steart has delivered enough intertidal habitat to meet the first epoch habitat losses. The new and improved tidal flood defences at Congresbury Yeo have also delivered 11 ha of intertidal habitat. Details on actual flood defence schemes and habitat creation projects were not sufficiently well-defined to adequately quantify the scale of effects.
Steart Managed Realignment Project (Bristol Ports)	Steart Habitat Creation Scheme proposes to create coastal habitats on the south bank of the Severn Estuary, along the Steart Peninsula in Bridgwater Bay. The scheme received planning permission in 2012, however, to date the scheme has not yet been implemented (it would only be implemented if the BDSCT were to be constructed).	An EIA was produced for the original site design (ABPmer, 2011). This project is therefore considered sufficiently well-defined to adequately quantify the scale of effects.
Cardiff Coastal Defence Scheme	This new flood defence which was consented in 2022 is anticipated to be completed in 2023. The project extends over an area of approximately 40 ha and comprises of the following activities: Rock revetment along the coast to manage erosion and wave overtopping; Sheet piling along Lamby Way roundabout (above MHWS); Maintain earth embankments elsewhere and raise low points in earth embankments where required to reduce flood risk; Rock scour protection added to Lamby Way Bridge; Vehicular access to construction site and traffic management.	NRW's EIA consent decision noted that the scheme will result in significant permanent direct and indirect Annex 1 habitat losses. An adverse effect on the integrity of the Severn Estuary SAC could not be ruled out. In line with Welsh Government policy, compensation will be provided through Welsh Government's National Habitat Creation Programme. The developer has committed not to pile below highest astronomical tide (HAT) and to use vibration piling as the preferred methodology. In addition, during the peak shad migration period (April and May) percussive pilling will only take place beyond 30 m of the HAT line.

19.3.1 Marine aggregate extraction

Marine aggregate extraction takes place at several approved sites within the Severn Estuary and Bristol Channel. Therefore, when considering the cumulative/in-combination impact associated with Bedwyn Sands and NMG, the total effect of marine aggregate extraction also needs to be considered. Table 19-2 presents background on those areas within the immediate and wider study area, i.e. the Severn Estuary and the Inner Bristol Channel. Table 19-2 presents maximum annual permitted extraction rates of all Licence Areas in the Severn Estuary / Bristol Channel (including Nobel Bank, which is located outside of the wider study area of this EIA, in the Outer Bristol Channel, some 102 km from NMG).

Table 19-2 Summary of marine aggregates dredging activities / plans in the wider study area

Project	Stage in Planning Process	Potential Impacts
Area 531 (4 km from NMG)	Active dredging site, with marine licence renewed in April 2021 with a licence term of 16 years. Maximum annual extraction of 150,000 t.	An ES was produced in 2019 (ABPmer, 2019). This project is therefore considered sufficiently well-defined to adequately quantify the scale of effects.
Culver Sands, Area 472 (33 km from NMG)	Relinquished dredging area (as of August 2019), marine licence acquired in 2008 with a licence term of 15 years. Maximum annual extraction was 1 Mt.	An ES was produced in February 2004 (Emu, 2004). Further assessments have taken place since then. Dredging has now ceased in Area 472, prior to its licence expiring.
Area 526 (Culver Sands Extension) (23 km from NMG)	Active dredging site, with a marine licence granted in January 2018 with a licence term of 15 years. Currently, around half (15.8 km^2) is available to dredge in an ADA. Maximum annual extraction of 2,000,000 t, up to a total of 10,000,000 t.	An ES was produced in 2017 (ABPmer, 2017a), and an addendum submitted in June 2017 (ABPmer, 2017b). This project is therefore considered sufficiently well-defined to adequately quantify the scale of effects.

Table 19-3 Maximum annual permitted extraction rates from Licence Areas in The Crown Estates South West Region

Site	Maximum Annual Extraction (tonnes)	Total Volume Landed in 2017 (tonnes)
Area 531	150,000	1,090,000
Culver Sands (Area 472)	1,000,000	
North Bristol Deep (Areas 470/1-2)**	250,000	
Nobel Bank (Area 476)*	2,000,000	
Culver Sands Extension (Area 526)	2,000,000***	

* Outside of wider study area of this EIA (102 km from NMG)
** Area 470 has since been replaced by Area 531
*** Combined annual offtake. Each of the three companies licensed to dredge on Area 526 has a licence to dredge 666,667 tonnes per annum.

An assessment of the cumulative / in-combination impacts of aggregate extraction has been provided in Section 19.4. This is supported by the description of the Severn Estuary and Bristol Channel region, as detailed in Section 5.2 of the ES, along with the assessment of potential effects on physical processes, detailed in Section 5.4. With regard to the potential in-combination effects of aggregate extraction from multiple sites within the Severn Estuary and Bristol Channel, the overall conclusion of the assessment is that it is considered unlikely that extraction of aggregate from NMG and Bedwyn Sands will result in any significant effect on the physical processes of the wider study area. This assessment is referenced in the relevant sections in Table 19-5 below.

A number of studies have assessed the cumulative effects of aggregate extraction in the Severn Estuary and Bristol Channel, including a detailed numerical wave modelling study (SEAWG, 2008). This study assessed the continued extraction of aggregates from the licensed areas within the estuary (including areas that have since been surrendered) and found no significant effect on the physical processes of the wider region. The approach to this study has been assessed within the present undertaking (as detailed in Section 5.2) and is considered to remain valid in supporting the present application.

The following dredging activity will not be considered further for the purpose of this cumulative and in-combination assessment, due to there either being no spatial or temporal overlap of potential effects (including indirect):

- Area 476 / Nobel Banks: due to the distances involved (and no apparent pathway overlap); and
- Area 472 / Culver Sands: due to the activities not overlapping temporally, given that the Area was relinquished in August 2019.

19.4 Cumulative/in-combination assessment

This impact assessment takes account of the existing activities and new developments identified above. The key pathways and receptors associated with all existing activities and new projects are highlighted below, followed by an assessment of all the receptors that are potentially affected by all pressures acting upon them.

Table 19-4 identifies any potential overlap of the plans, projects and/or activities with the physical, biological, historic and human environment receptors considered within this ES. Consideration is then given to the relevant pathways and an assessment undertaken of potential effects for each receptor.

Subsequently, a summary of the predicted cumulative/in-combination effects for each receptor is provided in Table 19-5, based on the pathways and receptors identified within Table 19-4.

Table 19-4 Potential overlap of plans, projects and/or activities with the physical, biological, historic and human environment receptors

Receptor (Impact Pathway)	Additional Aggregate Extraction	Ongoing Commercial and Recreational Fishing	Ongoing Shipping	Ongoing Ports and Navigation	Ongoing Recreation and Tourism	Disposal Sites	Hinkley and Steart managed realignment	Bristol Deep Sea Container Terminal	Flood Risk Management Plans and Projects, incl. ASEA
Physical Processes	✓	✓	✓	✓		✓		✓	✓
Water and Sediment Quality	✓	✓	✓	✓	✓	✓		✓	✓
Nature Conservation	✓	✓	✓	✓	✓	✓	✓	✓	✓
Benthic Ecology	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fish and Shellfish	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marine and Coastal Ornithology	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marine Mammals and Turtles	✓	✓	✓	✓	✓	✓		✓	✓
Commercial and Recreational Fisheries	✓	✓	✓	✓	✓	✓		✓	✓
Commercial Shipping and Recreational Navigation	✓	✓	✓	✓	✓	✓		✓	✓
Marine Archaeology	✓	✓	✓	✓	✓	✓		✓	✓
Coastal Protection and Flood Defence	✓	✓	✓	✓	✓	✓		✓	✓
Infrastructure and Other Marine Users	✓	✓	✓	✓	✓	✓		✓	✓
Human Health	✓	✓	✓	✓	✓	✓		✓	✓

Table 19-5 Summary of predicted cumulative/in-combination effects on receptors

Receptors	Summary of Predicted Cumulative and In-Combination Effects
Physical Processes	Cumulative/in-combination effects could occur to physical process receptors as a result of any activity or project in addition to aggregate extraction at Bedwyn Sands and NMG (see Section 5) which affects/disturbs the hydrodynamic and sediment regime. Four other licensed aggregate extraction areas currently exist in the Bristol Channel and Severn Estuary, though three of these (Areas 526, 476 and 472) have been excluded from this assessment (see Section 19.3.1). A number of studies have assessed the cumulative effects of aggregate extraction in the Severn Estuary and Bristol Channel, including a detailed numerical wave modelling study (SEAWG, 2008). This study assessed the continued extraction of aggregates from the licensed areas within the estuary (including areas that have since been surrendered) and found no significant effect on the physical processes of the wider region. The CIS undertaken for Bedwyn Sands and NMG by ABPmer included the adjacent aggregate extraction area (Area 531) in the cumulative modelling. Given the distances of over 23 km between NMG and the other licensed areas within the Inner Bristol Channel (526 and 472), as well as the presence of a well-known sediment parting zone between the Severn Estuary and the Inner Bristol Channel, there was not considered any potential for cumulative coastal processes effects, and these Licence Areas were thus not included in the modelling. The cumulative effects with dredging at Bedwyn Sands and NMG and Area 531 were considered to be insignificant (see Section 5.4.5). As part of the Bristol Deep Sea Container Terminal (BDSCT) ES (The Bristol Port Company, 2008), it was concluded that marine aggregate extraction schemes together with the development of the BDSCT (including capital dredge) would not result in any significant cumulative effect with respect to the impact on wave activity and tidal current patterns around the coast of the Severn Estuary. Predictive modelling work indicated that changes to tidal currents within the estuary are effectively limited to the area surrounding the Terminal itself and also largely within the footprint of the dredged channel. Given the small scale of the predicted changes and the fact that there is significant spatial separation between the predicted effect and any aggregate extraction areas, it was considered unlikely that there would be any potential for a cumulative effect on tidal current patterns and, therefore (by inference), any current induced change on sediment transport patterns (The Bristol Port Company, 2008). Regarding the sediment plume associated with capital dredging and disposal, it was considered that this would raise SSC approximately 50-500 mg/l above average background levels. Raised SSCs within the plume could extend over a wide area of the estuary, although this increase would effectively be masked by the already high background SSC levels. The extent of the plume has the potential for interaction with a plume generated by nearby aggregate extraction (e.g. Bedwyn Sands); however, it was highlighted that the proportion of fine sediment within aggregate deposits is low and considerably less than that of the sediments to be dredged for the Terminal. The potential for an additive effect, if aggregate extraction and dredging for the BDSCT were to take place at the same time is therefore very small. The SSC of the plume generated during dredging for the BDSCT would far overwhelm any SSC increase associated with aggregate dredging and the additive effect would probably still fall within the range of impact solely associated with the BDSCT dredge plume (The Bristol Port Company, 2008). The Hinkley Point C capital dredging for the jetty berthing pocket and intakes has concluded. Thus there is no temporal overlap of impacts related to disposal in the LU110 disposal site and dredging in Bedwyn Sands and NMG. The disposal of maintenance dredge arisings at LU070 disposal site (Portishead) has the potential to temporally overlap with dredging in Bedwyn Sands and NMG. Despite this, the high background SSC levels of the Severn Estuary, as well as the low fine sediment content of the dredged materials would be unlikely to lead to a detectable cumulative impact. The same applies to any other ongoing or *ad hoc* disposal activity in the disposal sites which are within 10 km of Bedwyn Sand and NMG. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The well-defined ASEA works are mainly land-based, and any marine works are predicted to have very localised impacts (CH2M, 2018). The construction of the Cardiff Coastal Defence Scheme will take place either above tidal areas or under dry conditions. No material will be stored on the foreshore and there is limited risk that works will mobilise beach sediment into the sea (Cardiff Council, 2021). The works will therefore have no significant effect upon the local hydrodynamic or sediment regime. Cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely.

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	Overall, given the small scale of any changes that are expected as a result of aggregate extraction at Bedwyn Sands and NMG, there is no potential for cumulative/in-combination effects. Therefore, when considering the scale of other activities and plans, no significant impacts are expected with regards to physical processes.
Water and Sediment Quality	Cumulative/in-combination effects could occur to water and sediment quality as a result of any activity or project in addition to aggregate extraction at Bedwyn Sands and NMG (see Section 6) which results in increased SSCs or affects/disturbs contaminated sediment, as well as those developments which could result in the spillage/release of toxic contaminants. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. Localised temporary increases in SSC are predicted for these activities in geographically distinct areas (i.e. no interaction in terms of water quality). In all instances, changes in SSC would be within the levels of natural variability, and (beyond the immediate impact area) not detectable above the high background levels of the Estuary. Given the sandy nature of the targeted dredge sediments in the wider study area, the potential for sediment bound contamination to be present is relatively low. As noted in the previous row, Bedwyn Sands and NMG and the potential BDSCT have the potential to result in cumulative/in-combination effects related to increases in SSC and overlapping of plumes. The anticipated increases in the SSC due to the BDSCT development is expected to be within the natural variation of the Severn Estuary and hydrodynamic modelling has indicated that the sediment plume generated by the dredge will not extend into the upper reaches of the Severn Estuary. In terms of remobilisation of contaminants, the impact of the capital dredging and disposal is predicted to be of minor adverse impact (The Bristol Port Company, 2008). The proportion of fine sediment within the aggregate deposits at Bedwyn Sands and NMG is low and considerably less than that of the sediments to be dredged by BDSCT. It is therefore unlikely that high SSC concentrations would be generated during aggregate extraction (also see Section 6.3). The potential for an additive effect, if aggregate extraction and dredging for BDSCT were to take place at the same time is therefore very small. The SSC of the plume generated during dredging for BDSCT would far overwhelm any SSC increase associated with aggregate dredging and the additive effect would probably still fall within the range of impact solely associated with the BDSCT dredge plume (The Bristol Port Company, 2008). The sediments at Avonmouth are likely to contain significant levels of contaminants which could be re-mobilised during the construction and subsequent dredging of BDSCT development. However, given the low level of contaminants predicted in the resource at Bedwyn Sands and NMG, this would not result in a significant cumulative/in-combination effect. At Hinkley Point C, capital dredging for the jetty berthing pocket and intakes has concluded. Thus there would be no temporal overlap of impacts related to disposal in the LU110 disposal site and dredging in Bedwyn Sands and NMG. The disposal of maintenance dredge arisings at LU070 disposal site (Portishead) has the potential to temporally overlap with dredging in Bedwyn Sands and NMG. Despite this, the high background SSC levels of the Severn Estuary, as well as the low fine sediment content of the dredged materials would be unlikely to lead to a detectable cumulative impact. The same applies to any other ongoing or *ad hoc* disposal activity in the disposal sites which are within 10 km of Bedwyn Sand and NMG. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures, and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The well-defined ASEA works are mainly land-based, and any marine works are predicted to have very localised impacts (CH2M, 2018); hence, cumulative/ in-combination impacts are considered unlikely. The construction of the Cardiff Coastal Defence Scheme will take place either above tidal areas or under dry conditions (Cardiff Council, 2021). No material will be stored on the foreshore and there is limited risk that works will mobilise beach sediment into the sea. The works will therefore have no significant effect upon the local hydrodynamic or sediment regime. Cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely.

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	Overall, given the highly localised nature of any changes that are expected as a result of aggregate extraction at Bedwyn Sands and NMG, there is no potential for cumulative/in-combination effects. Therefore, when considering the scale of other activities and plans, no significant impacts are expected with regards to water and sediment quality.
Nature Conservation	Cumulative/in-combination effects could occur to qualifying nature conservation designations species (see Section 7) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could result in loss/damage and/or disturbance of qualifying habitats and species, loss or changes to foraging habitat, toxic contamination, non-toxic contamination and noise and visual disturbance. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. None of the EIAs of these projects, as well as that for Bedwyn Sands and NMG, concluded that features associated with protected sites would be significantly affected. With regard to the SAC, impacts on the Bedwyn Sands and NMG features, have been subject to annual monitoring, which would be anticipated to continue and be written as licence conditions under the renewed licence for these areas. Impacts on seabirds and wading birds were considered to be insignificant by all related ESs, and due to this, and the low usage of the dredging areas, no cumulative/in-combination impact are predicted. Area 526, whilst not in the vicinity of Bedwyn Sands and NMG, has a small section which forms part of the SAC. It was considered during its EIA that 'extraction from Area 526 will not result in a reduction in sand transport to the sedimentary features within the Severn Estuary' (ABPmer, 2017b), and thus no cumulative/in-combination impact are predicted with Bedwyn Sands and NMG included. The development of the BDSCT would give rise to various effects in relation to the conservation objectives of the Severn Estuary SAC, SPA and Ramsar sites. Having regards to the potential magnitude of these effects, the project's ES suggested that the following effects are of greatest significance with respect to the objectives of these designations (The Bristol Port Company, 2008): ▪ The permanent loss of a small area of intertidal habitat from within the SPA and SAC; ▪ Alteration of conditions that support characteristic benthic communities within an area of approximately 80 ha of intertidal mudflat due to increased accretion; and ▪ Resulting from the above, a reduction (that could be temporary) in available feeding resources for waterfowl and waders, within the above (80 ha) intertidal area of approximately 60 ha of intertidal area due to potential changes in the benthic community. The effects of the BDSCT are mostly related to intertidal benthic communities (for which compensation is to be provided, amongst others with the Steart managed realignment). Based on the assessment of effects on nature conservation features as a result of dredging activity at Bedwyn Sands and NMG (see Sections 8, 9, 10 and 0), it is not anticipated that there will be any cumulative/ in-combination effects. The Steart managed realignment will result in an increase in intertidal habitat, resulting in a long-term increased capacity to support water birds throughout Bridgwater Bay. Aggregate extraction at Bedwyn Sands and NMG is not expected to impact significantly on the intertidal designated features of the overlapping or nearby sites. Therefore, it is not anticipated that there will be any cumulative / in-combination effects. The Hinkley Point C ES assessed the effects of various stages of the project on the features of surrounding designated sites of conservation importance. The majority of effects ranged from negligible to minor. No physical impacts, such as habitat loss or suspended sediment plumes are expected to overlap with those resulting from dredging in Bedwyn Sands and NMG. No cumulative/in-combination effect between Hinkley Point C and dredging in Bedwyn Sands and NMG are therefore anticipated. The decommissioning of Hinkley Point A is not expected to have a significant impact on the marine environment and therefore a cumulative impact will not occur. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures, and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely.

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The well-defined ASEA works are mainly land-based, though most of the works overlap with the Severn Estuary SAC and SPA (as well as Ramsar and SSSI components) and comprehensive mitigation and (mostly terrestrial) compensation measures are included in the project, to compensate for landward ornithological and habitat impacts. Due to this, and Bedwyn Sands and NMG not predicted to have significant adverse effects on bird or habitat features, cumulative/ in-combination impacts are considered unlikely. During construction of the Cardiff Coastal Defence Scheme, there is potential to impact upon the features of the Severn Estuary European Marine Site (Cardiff Council, 2021). Construction may disturb wintering wildfowl and wading bird species, if the works are carried out during the wintering period. Plant movement has the potential to negatively impact intertidal habitats through compaction of the foreshore. In addition, there is the potential to negatively impact marine habitats through pollution incidents. Any mitigation requirements to reduce the significance of construction impacts to acceptable levels will be secured using appropriate conditions. Any habitat lost as a result of the defence footprint and coastal squeeze will be replaced with compensatory habitat. Cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely. Overall, it is considered that aggregate extraction will not substantially change the current baseline and the cumulative/in-combination effects are very small in relation to the wider study area and when considering the scale of other activities and plans. The occurrence of significant adverse cumulative/in-combination effects is considered unlikely, though considerable uncertainty remains due to the relatively limited information available on future projects, including potential compensation measures.
Benthic Habitats and Species	Cumulative/in-combination effects could occur to benthic ecology (see Section 8) as a result of any activity or project in addition to aggregate extraction at Bedwyn Sands and NMG which can result in the loss of and/or damage to benthic habitats, changes in SSCs, fine sand dispersion or sediment flux, bathymetric changes, increase in noise levels and the introduction of non-native species. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. Overall, impacts on benthic habitats and species receptors from dredging in Bedwyn Sands and NMG alone are considered to be insignificant to minor adverse with mitigation. The other ESs for the nearby dredging sites reached the same conclusion for the individual licence renewals / applications. Given the localised impacts and the generally impoverished nature of the benthic ecology, as well as the fact that no long-term habitat change *per se* is anticipated (subject to established mitigation and monitoring measures), no cumulative / in-combination impacts are anticipated from aggregates dredging. Regarding fisheries and aggregate dredging, the combined impacts of these activities, have the potential to affect benthic ecology by disturbing the seabed and/or resulting in a loss of habitat. There could also be indirect impacts on the availability of prey species. Fishing activity is very low within the study area (see Section 12 of the ES), and mostly utilises methods which do not significantly affect the seabed (rod and line chiefly, some potting, not trawling). Therefore, no cumulative impacts with fishing are predicted to occur. Dredging in Bedwyn Sands and NMG and the potential BDSCT have the potential to result in cumulative/in-combination effects such as increase in SSC. The BDSCT project, in the long term, is predicted to result in the accumulation of additional fine sediment in existing sinks in the estuary, most notably in the subtidal areas of Bridgwater Bay. The unstable muds forming these sink areas has extremely high-water content and does not support any notable infauna and is considered to be of low ecological value. The subtidal effect of this accretion was therefore considered to be of minor adverse at worst to negligible. Enhanced intertidal accretion could also occur due to the construction of the terminal and capital dredging. Overall, the likelihood of such significant adverse effects occurring in relation to intertidal areas in the wider system was considered unlikely. Compensation in the form of the Steart managed realignment scheme was to be provided for localised direct and indirect adverse effects at Avonmouth on intertidal habitats and birds (The Bristol Port Company, 2008). The dredging at Bedwyn Sands and NMG (essentially a continuation from existing activities), will not lead to the loss of any habitat and will not significantly change the height of the seabed (return to pre-dredge conditions often within one tidal cycle). The predicted plume and bedform impacts from dredging from Bedwyn Sands and NMG will be highly localised, with deposition of

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	sediment restricted to within the SIZ, and plume effects beyond this SIZ not being noticeable above the high background levels characteristic of the Severn Estuary. In conclusions, no cumulative/in-combination effects are anticipated related to the Terminal and dredging in Bedwyn Sands and NMG. The Bristol Port's Steart managed realignment will result in an increase in intertidal habitat with no long-term effect on subtidal habitat. Aggregate extraction at Bedwyn Sands and NMG is not expected to significantly impact on intertidal areas. Therefore, it is not anticipated that there will be any cumulative / in-combination effects. The majority of effects on marine ecology from the construction and operation of Hinkley Point C were assessed as negligible to minor. However, the physical disturbance to intertidal habitats as a result of barge delivery of rock armour to the shore was assessed as moderate. Mitigation measures, including restricted landing area, reduced the residual effect to minor. There is no potential for overlap of physical disturbance resulting from the two projects. Given this, no cumulative/in-combination effect between Hinkley Point C and dredging in Bedwyn Sands and NMG are anticipated. The decommissioning of Hinkley Point A is not expected to have a significant impact on the marine environment and therefore a cumulative impact will not occur. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures, and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works are mainly land-based, and any marine works are predicted to have very localised impacts; hence, cumulative/ in-combination impacts are considered unlikely. The permanent works footprint of the Cardiff Coastal Defence Scheme will directly impact approximately 1.41 ha of intertidal habitat in the Severn Estuary and 0.94 ha of intertidal habitat in the Rhymney River (Cardiff Council, 2021). The scheme will directly impact 1.59 ha of saltmarsh and has the potential to further impact saltmarsh and intertidal mudflats in the Rhymney and the Severn through the provision of access tracks and site compounds. Any habitat lost as a result of the defence footprint will be replaced with compensatory habitat. Cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely. Overall, given the highly localised nature of any changes that are expected as a result of aggregate extraction at Bedwyn Sands and NMG, there is no potential for cumulative/in-combination effects. Therefore, when considering the scale of other activities and plans, no significant impacts are expected.
Fish and Shellfish	Cumulative/in-combination effects could occur to fish and shellfish (see Section 9) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could remove seabed on spawning, nursery and overwintering grounds, change water quality and create noise and vibration effects. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. Overall, impacts on fish and shellfish ecology receptors from dredging in Bedwyn Sands and NMG alone were considered to be insignificant, with the exception of sandeel impacts, which were considered to be potential insignificant to minor. The other ESs for the nearby dredging sites reached the same conclusion for the individual licence renewals / applications. Given the localised impacts, as well as the fact that no long-term habitat change *per se* is anticipated (subject to established mitigation and monitoring measures), no cumulative / in-combination impacts are anticipated from aggregates dredging. There are a number of potential impact pathways associated with the BDSCT development and the fish and shellfish receptors, including entrainment by the dredger head, elevated suspended solids and contaminants, acoustic impacts resulting from the capital dredge and impacts on migration routes. However, all impact pathways have been assessed as negligible to minor adverse at worst (The Bristol Port Company, 2008). Therefore, given the minimal impacts anticipated in association with the dredging activities at Bedwyn Sands and NMG, it is unlikely for the two projects to result in a cumulative/in-combination effect. The Steart managed realignment will result in an increase in intertidal habitat, resulting in a long-term increased capacity to support fish, particularly juveniles, throughout Bridgwater Bay. Aggregate extraction at Bedwyn Sands and NMG is not expected to impact significantly on fish or shellfish species (except for sandeel,

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	which would not be impacted at Steart due to the muddy nature of the environment there). Therefore, it is not anticipated that there will be any cumulative / in-combination effects. Hinkley Point C will have a negative operational impact on fish populations primarily as a result of entrainment and entrapment of individuals at the cooling water intakes. Bedwyn Sands and NMG supports a limited number and range of fish and shellfish. Due to the highly localised, small-scale changes predicted as part of the dredging, and established industry mitigation measures, there is considered to be no potential for cumulative/in-combination effects. The decommissioning of Hinkley Point A is not expected to have a significant impact on the marine environment and therefore a cumulative impact will not occur. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures (with associated noise and habitat impacts), and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most of the FRMP structures in the Severn Estuary remains unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works are mainly land-based, and any marine works are predicted to have very localised impacts on the high intertidal; hence, cumulative/ in-combination impacts are considered unlikely. To alleviate concerns regarding the impact pathway from noise and vibration upon twaite shad as a result of the construction of the Cardiff Coastal Defence Scheme, the developer (Cardiff Council) has committed not to pile below HAT and to use vibration piling as the preferred methodology. Percussive piling will only be used when it is strictly necessary and will only take place above HAT. In addition, during the peak shad migration period (April and May) percussive pilling will only take place beyond 30 m of the HAT line. With these proposed mitigation measures in place, cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely. Overall, it is considered that the proposed aggregate extraction will not substantially change the current baseline and the cumulative/in-combination effects are very small in relation to the wider study area and when considering the scale of other activities and plans. The occurrence of significant adverse cumulative/ in-combination effects is considered unlikely, although considerable uncertainty remains due to the relatively limited information available on future projects.
Marine and Coastal Ornithology	Cumulative/in-combination effects could occur to marine and coastal bird species (see Section 10) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could remove seabed (including prey availability), have an impact on foraging due to suspended sediment plumes and fine sand dispersion and create disturbance generated by vessel presence. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. Overall, impacts on marine and coastal ornithology receptors from dredging in Bedwyn Sands and NMG alone were considered to be insignificant. The other ESs for the nearby dredging sites reached the same conclusion for the individual licence renewals / applications. Given the localised impacts, as well as the low bird density and the fact that no long-term habitat change *per se* is anticipated (subject to established mitigation and monitoring measures), no cumulative / in-combination impacts are anticipated from aggregates dredging. A range of potential impacts on ornithological features are assessed as part of the BDSCT project's ES (The Bristol Port Company, 2008), including the reclamation/loss of habitat within the footprint of the container terminal, accumulation of fine sediment on intertidal areas upstream of the container terminal as a result of changes to tidal flows and sediment transport, conversion of intertidal mudflat to saltmarsh as a result of accretion and disturbance to feeding and roosting birds on adjacent intertidal areas during construction. However, for all impact pathways, with the exception of the reclamation/loss of habitat for redshank (moderate adverse), the significance was considered negligible to minor at worst (with compensation to be provided at Steart, amongst others). Given the dredging activity at Bedwyn Sands and NMG will not change the overall extent of intertidal habitat in the wider study area, it is predicted that there will be no potential for cumulative/in-combination effects.

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	The Steart managed realignment will result in an increase in intertidal habitat, resulting in a long-term increased capacity to support water birds throughout Bridgwater Bay. Due to the negligible exposure of birds to the potential impacts as a result of aggregate extraction at Bedwyn Sands and NMG, it is not anticipated that there will be any cumulative / in-combination effects. Hinkley Point C has the potential to cause significant impacts through clearance of vegetation and noise, visual and lighting disturbance. However, due to the proposed mitigation and habitat creation measures as part of the scheme, effects on ornithology are considered to be minor (EDF, 2011). Due to the negligible exposure of birds to the potential impacts as a result of aggregate extraction at Bedwyn Sands and NMG, it is not anticipated that there will be any cumulative / in-combination effects. The decommissioning of Hinkley Point A is not expected to have a significant impact on the marine environment and therefore a cumulative impact will not occur. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and outtake structures (with associated noise and habitat impacts),, and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works are mainly land-based, any overwintering bird impacts are to be minimised through careful timing of works, as well as on site ornithologists. Habitat related impact are mainly landward, and compensation / mitigation is being provided so that over impacts on birds are considered to be positive. During construction of the Cardiff Coastal Defence Scheme, there is the potential to disturb wintering wildfowl and wading bird species should the project impact upon the foreshore areas (Cardiff Council, 2021). Additionally, re-routing the Wales Coast Path either temporarily or permanently has the potential to disturb wintering and migratory birds if the path results in walkers breaking the skyline. (although no change to the route of the Path is proposed). Cumulative/ in-combination impacts with aggregate extraction activities at Bedwyn Sands and NMG are, therefore, considered unlikely. Overall, it is considered that aggregate extraction from Bedwyn Sands and NMG will not substantially change the current baseline. Effects of aggregate extraction are very small in relation to the wider study area and when considering the scale of other activities and plans. The occurrence of significant adverse cumulative/in-combination effects is considered unlikely, though considerable uncertainty remains due to the relatively limited information available on future projects.
Marine Mammals and Turtles	Cumulative/in-combination effects could occur to marine mammals and turtles (see Section 10) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which affects/disturbs the seabed, reduces water clarity, creates noise and vibration effects and has the potential to cause collision risk due to vessel movements. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. Impacts on marine mammal and turtle receptors from dredging in Bedwyn Sands and NMG alone were considered to be insignificant. The other ESs for the nearby dredging sites reached the same conclusion for the individual licence renewals / applications. Other activities and plans within the region are considered to have the potential to impact marine mammals (e.g. fisheries by-catch). However, fishing activity in the study area is very low and low impact with regard to marine mammals. Thus, in/combination / cumulative impacts regarding aggregates and fishing activities are not anticipated. Marine mammals and turtles were not assessed as part of the BDSCT ES (The Bristol Port Company, 2008); however, it is anticipated that the project will not have a significant impact on these receptors. Therefore, cumulative/in-combination effects are not anticipated with the dredging activities at Bedwyn Sands and NMG. Hinkley Point C has the potential to cause significant impacts through noise disturbance (in relation to marine construction works and vessel movements), as well as water quality and prey effects. However, due to the proposed mitigation measures as part of the scheme / during construction, effects on marine mammals are considered to be minor (EDF, 2011). Due to the negligible exposure of marine mammals to the potential impacts as a result of aggregate extraction at Bedwyn Sands and NMG, it is not anticipated that there will be any cumulative / in-combination effects. The decommissioning of Hinkley Point A is not expected to have a significant impact on the marine environment and therefore a cumulative impact will not occur. Hinkley Point B's decommissioning will involve the dismantling of the cooling water intake and

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	outtake structures (with associated noise and habitat impacts), and discharges during decommissioning may also impact the marine environment. Given the distances involved, cumulative impacts are considered unlikely. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works and the Cardiff Coastal Defence Scheme are mainly land-based, and any marine works are predicted to have very localised impacts on the high intertidal; hence, cumulative/ in-combination impacts are considered unlikely. Overall, given the highly localised nature of any changes that are expected as a result of dredging at Bedwyn Sands and NMG, there is no potential for cumulative/in-combination effects. Therefore, when considering the scale of other activities and plans, no significant impacts are expected.
Commercial and Recreational Fisheries	Cumulative/in-combination effects could occur to commercial and recreational fisheries (Section 12) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could result in disruption of fisheries activities due to vessel movements, potential for fishing gear damage and impacts to fishing activities and fish stocks due to removal of the seabed. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are present in the wider study area (i.e. the Severn Estuary and Inner Bristol Channel). Overall, impacts on fisheries receptors from dredging in Bedwyn Sands and NMG alone were considered to be insignificant. The other ESs for the nearby dredging sites reached the same conclusion for the individual licence renewals / applications. This was with the exception of the Area 526 ES, where a potentially minor adverse effect was identified for recreational angling charters. As noted in Section 12.2.2, Bedwyn Sands and NMG are areas fished by charter vessels for winter cod. Data on charter fishing vessels is unavailable but according to online searches, there are charter vessels based in Penarth, Wales; Cardiff, Wales; and Portishead, England; which are likely to fish in the study area. For Area 526, charters from Penarth, Swansea, Watchet and Minehead were found to fish over Culver Sands. Thus, there is some potential overlap. However, the assessment for Area 526 assumed dredging over the whole of Area 526, as well as within Area 472. Given that the Area 526 licence holders (TM, HAM and CEMEX) have declared a smaller ADA, and have ceased dredging in Area 472, impacts at Culver Sands would be reduced. Furthermore, at Bedwyn Sands and NMG, dredging is already ongoing, and essentially co-existing with charter anglers. For these reasons, it is not considered that additive cumulative impacts of a significantly adverse nature would occur. There are a number of potential impact pathways associated with the BDSCT development and the fisheries resource, including entrainment by the dredger head, elevated suspended solids and contaminants, acoustic impacts resulting from the capital dredge and impacts on migration routes. However, all impact pathways related to fish ecology have been assessed as negligible to minor adverse at worst (The Bristol Port Company, 2008). With regard to fisheries, there would either be no impact (at the port), or only very temporary impacts (during the capital dredge), though even then significant displacement impacts are unlikely, given that fishing would typically be in shallower areas away from the navigation channel. Therefore, given the minimal impacts anticipated in association with dredging activities at Bedwyn Sands and NMG, it is unlikely for the two projects to result in a cumulative/ in-combination effect. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works and the Cardiff Coastal Defence Scheme are mainly land-based, and no fisheries related impacts are predicted; hence, cumulative/ in-combination impacts are considered unlikely. Overall, it is considered that the proposed aggregate extraction will not substantially change the current baseline and the cumulative/in-combination effects are very small in relation to the wider study area and especially when considered against the scale of other activities and plans, including from commercial fisheries.
Commercial Shipping and Recreational Navigation	Cumulative/in-combination effects could occur to commercial shipping and recreational navigation (Section 13) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could result in increased vessel movements and risk of collision.

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. The assessment in this EIA concluded that the potential displacement of commercial and recreational vessels due to dredger operation at Bedwyn Sands and NMG could lead to a minor risk of accidents and incidents relating to transit and operation and a minor potential for water quality impacts resulting from incidents. With the embedded mitigation, the risk is considered to be as low as reasonably practicable ('ALARP'). It was concluded that these impacts are not of a scale requiring further specific mitigation. The nature of the BDSCT development will lead to an increase in the volume and size of vessels entering the Port of Bristol, which will result in a minor adverse impact on existing commercial traffic within the estuary (The Bristol Port Company, 2008). Bedwyn Sands and NMG relates to a continuation of dredging activity in these Renewal Areas and given the scale of vessel operations involved, it is unlikely for the two projects to result in a significant cumulative/in-combination effect. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works and the Cardiff Coastal Defence Scheme are mainly land-based, and no navigation related impacts are predicted; hence, cumulative/ in-combination impacts are considered unlikely. Overall, it is considered that the proposed aggregate extraction will not substantially change the current baseline and the cumulative/in-combination effects are very small in relation to the wider study area and especially when considered against the scale of other activities and plans, particularly the BDSCT project.
Marine Archaeology	Cumulative/in-combination effects could occur to marine archaeology receptors (Section 14) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which could result in the disturbance or damage of archaeological remains. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. The assessment in this EIA concluded that there could be potential minor adverse impacts on marine archaeology. The ESs for nearby aggregate areas reached similar conclusions. It is considered that, as long as standard industry mitigation measures (see Section 14) are observed by all operators, no significant cumulative / in-combination impacts should arise from aggregate dredging. There are a number of potential impact pathways associated with the BDSCT development and marine archaeology receptors, including the impact of construction (dredging) on known/unknown wrecks and hydrodynamic effects during the operation of the port. However, other than known wreck locations (moderate adverse impact), the significance was considered negligible to minor at worst due to the 'potential' interaction with submerged archaeological features (The Bristol Port Company, 2008). Given the small risk anticipated in association with the dredging activities at Bedwyn Sands and NMG, and considering the existing mitigation measures for aggregates, it is unlikely for the two projects to result in a significant cumulative/in-combination effect. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works are mainly land-based, and any marine works are predicted to have very localised impacts; hence, cumulative/ in-combination impacts are considered unlikely. Groundbreaking at some locations for the Cardiff Coastal Defence Scheme will be through tidal flat deposits (Cardiff Council, 2021). There is a risk of encountering unknown archaeological remains in these deposits. Any further pre-construction ground investigation works will be monitored, and the results analysed to further determine the potential for encountering unknown archaeological remains and palaeoenvironmental deposits. In addition, drone monitoring of the mudflat levels, and the wider intertidal area adjacent to the site, will be undertaken annually over a period of five years. With these measures in place, cumulative/in-combination effects with Bedwyn Sands and NMG are considered unlikely. In summary, significant uncertainty exists with regard to the cumulative/in-combination effects of plans/projects which are currently within the planning domain. It is considered that, without mitigation, there is the potential for significant adverse cumulative effects to occur to archaeological resources, particularly in relation to seabed removal impacts and prehistoric archaeology resulting from aggregates dredging and other seabed activities (notably the capital dredge related to the BDSCT). However, with project specific mitigation, it should be possible to reduce impacts to acceptable (residual) levels (i.e. minor at worst). Mitigation measures would include

Receptors	Summary of Predicted Cumulative and In-Combination Effects
	the adherence to/implementation of exclusion zones to protect maritime and aviation archaeology, but also potentially areas found to be of high prehistoric value. The aggregates dredging industry would be expected to adhere to established mitigation measures.
Coastal Protection and Flood Defence	Cumulative/in-combination effects could occur to coastal protection and flood defence receptors (Section 15) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG. However, the assessment at Bedwyn Sands and NMG has concluded that, as dredging activities at Bedwyn Sands and NMG are not expected to impact the coast in relation to changes in wave height and tidal currents as well as beach draw down, and they are expected to have a minor beneficial effect on coastal defence through providing aggregate for the construction of defences, the overall impact with regard to coastal protection and flood defence would be insignificant. Similar conclusions were reached in the ESs for other activities (notably aggregates) considered for this assessment, and many of the other projects considered in fact will lead to improved standards for this receptor (notably ASEA, Cardiff Coastal Defence Works, BDSCT and Hinkley C). Therefore, there are no predicted cumulative / in-combination effects as a result of all projects and activities considered.
Air Quality	Cumulative/in-combination effects could occur to air quality (Section 16) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG. However, the assessment of the anticipated air emissions resulting from the proposed marine aggregate operations has concluded that overall, the impact on existing air quality is considered to be insignificant and will not require any mitigation. Therefore, there are no predicted cumulative / in-combination effects as a result of all projects and activities considered.
Infrastructure and Other Marine Users	Cumulative/in-combination effects could occur to marine/coastal infrastructure and other marine user receptors (Section 17) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG which results in seabed removal and/or disturbance, affects vessel displacement, noise and vibration levels, suspended sediment concentrations, waves, tides and sediment flux. In addition to Bedwyn Sands and NMG, three other licensed aggregate extraction sites are expected to be operational in the wider study area once dredging commences in Bedwyn Sands and NMG. The assessment at Bedwyn Sands and NMG has concluded that, as dredging activities at Bedwyn Sands and NMG are not expected to impact the coast in relation to changes in wave height and tidal currents as well as beach draw down, the overall impact with regard to coastal protection and flood defence would be insignificant. Similar conclusions were reached in the ESs for other aggregates activities in the area. There are a number of potential impact pathways associated with the BDSCT development and infrastructure and other marine user receptors, such as three 2 MW turbines located on the Avonmouth Foreshore and an oil jetty. However, the project's ES indicated no significant impacts were anticipated (The Bristol Port Company, 2008). Given the minimal impacts associated with dredging activities at Bedwyn Sands and NMG on infrastructure and other marine user receptors, it is unlikely for the two projects to result in a cumulative/in-combination effect. The scale and location of most of the FRMP structures in the Severn Estuary remain unclear and, therefore, it is not possible to determine the potential cumulative/in-combination effects of the plans with continued dredging activities at Bedwyn Sands and NMG. The ASEA works and Cardiff Coastal Defence Scheme are mainly land-based, and any marine works are predicted to have very localised impacts; hence, cumulative/ in-combination impacts are considered unlikely. Overall, it is considered that the proposed aggregate extraction will not substantially change the current baseline and the cumulative/in-combination effects are very small in relation to the wider study area and especially when considered against the scale of other activities and plans. The occurrence of significant adverse cumulative/ in-combination effects is considered unlikely, though considerable uncertainty remains due to the relatively limited information available on future projects.
Human Health	Cumulative/in-combination effects could occur to human health (Section 18) as a result of any activity or project in addition to dredging at Bedwyn Sands and NMG. An assessment on human health considering air quality, noise and light pollution resulting from the proposed marine aggregate operations in Bedwyn Sands and NMG concluded that effects will be insignificant and will not require any mitigation. Therefore, there are no predicted cumulative / in-combination effects as a result of all projects and activities considered.

19.5 Summary and conclusions

Overall, whilst uncertainty exists with regard to the cumulative/in-combination effects of some of the plans/projects that are yet to be approved, it is considered that the proposed aggregate extraction will not substantially change the current baseline, particularly given that the proposed activity is already undertaken and well established in the region, and the cumulative/in combination effects are very small in relation to the wider study area, especially when considered against the scale of other activities and plans (notably windfarms). The occurrence of significant adverse cumulative/in-combination effects is therefore considered unlikely.

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20 Mitigation and Monitoring

This section provides a summary of all the mitigation measures proposed in the impact assessments throughout this ES (see Section 20.1), along with acknowledgement of the anticipated monitoring requirements (see Section 20.2).

20.1 Impact/mitigation summary

Standard best practice procedures and impact reduction measures have been considered as part of the application to minimise the potential impact(s) on different receiving environments. Some of these mitigation measures are recommendations of the impact assessment process, whilst others have been incorporated into the design of the development. Table 20-1 summarises the predicted impacts associated with dredging activities in Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459). The table shows the significance of each potential impact, proposed mitigation measures and the significance of the residual impact (i.e. the impact remaining following the implementation of mitigation measures).

A detailed monitoring programme will be written into the licence conditions where necessary, following common industry practice and up to date requirements from NRW/MMO and its advisors (based on standard licence conditions). It is assumed that this will largely be in line with the existing monitoring practices currently being observed at Bedwyn Sands and NMG.

Table 20-1 Potential impacts, mitigation measures and residual impacts associated with dredging at Bedwyn Sands and NMG

Receptor	Potential Impact Pathway	Impact Significance	Mitigation	Residual Impact
Physical Processes	Effects on the coastline due to changes in wave height and tidal currents (Section 5.4.1)	Insignificant	None required beyond established industry mitigating practices, and continuation of monitoring (see Section 20.2).	Insignificant
	Reduction in beach volume from 'draw-down' of material into the dredged areas (Section 5.4.2)	Insignificant		Insignificant
	Effects on the coastline due to changes in sediment transport pathways (Section 5.4.3)	Insignificant		Insignificant
	Effects on bedforms within the wider study area (Section 5.4.4)	Insignificant		Insignificant
	Cumulative effects on the coast with ongoing dredging in other sites within the study area (Section 5.4.5)	Insignificant		Insignificant
Water and Sediment Quality	Potential changes to suspended sediment concentrations (Section 6.3.1)	Insignificant	None required	Insignificant
	Potential changes to dissolved oxygen (Section 6.3.2)	Insignificant	None required	Insignificant
	Potential changes to levels of contaminants in water (Section 6.3.3)	Insignificant	None required	Insignificant
	Potential impacts from redistribution of sediment-bound chemical contaminants (Section 6.3.4)	Insignificant	None required	Insignificant
Nature Conservation and Ecology	Relevant features have been assessed in the respective marine ecology section.	Considered within individual receptors	Considered within individual receptors	Considered within individual receptors
Benthic Species and Habitats	Potential impacts to benthic species and habitat receptors from seabed removal (Section 8.3.1)	Minor adverse (general benthic habitats and species) Insignificant (*Sabellaria* reefs)	Best practice procedures (Section 3.5)	Minor adverse (general benthic habitats and species) Insignificant (*Sabellaria* reefs)
	Potential impacts to benthic species and habitat receptors due to the suspended sediment plume (Section 8.3.2)	Insignificant (general benthic habitats and species) Insignificant (*Sabellaria* reefs)	Best practice procedures (Section 3.5)	Insignificant (general benthic habitats and species) Insignificant (*Sabellaria* reefs)
	Potential impacts to benthic species and habitat receptors due to fine sand deposition and dispersion (including bedform) (Section 8.3.3)	Insignificant (general benthic habitats and species) Insignificant (*Sabellaria* reefs)	Best practice procedures (Section 3.5)	Insignificant (general benthic habitats and species) Insignificant (*Sabellaria* reefs)
	Potential impacts to benthic species and habitat receptors due to bathymetric changes following dredging (Section 8.3.4)	Insignificant	Best practice procedures (Section 3.5)	Insignificant Insignificant (*Sabellaria* reefs)
	Potential disturbance of benthic invertebrate receptors due to noise (Section 8.3.5)	Insignificant	Best practice procedures (Section 3.5)	Insignificant Insignificant (*Sabellaria* reefs)

Receptor	Potential Impact Pathway	Impact Significance	Mitigation	Residual Impact
	Potential impacts through the introduction of non-native species (Section 8.3.6)	Insignificant	Best practice procedures (Section 3.5)	Insignificant Insignificant (*Sabellaria* reefs)
Fish and Shellfish	Potential impacts of seabed removal on spawning, nursery and feeding grounds (direct and indirect effects) (Section 9.3.1)	Insignificant (indirect effects (food chain)) Insignificant (indirect effects (habitat change)) Insignificant (direct effects (uptake)- finfish) Insignificant (direct effects (uptake)- shellfish general (excluding brooding Crustacea)) Insignificant (direct effects (uptake)- shellfish (brooding Crustacea))	Best practice procedures (Section 3.5)	Insignificant (indirect effects (food chain)) Insignificant (indirect effects (habitat change)) Insignificant (direct effects (uptake)- finfish) Insignificant (direct effects (uptake)- shellfish general (excluding brooding Crustacea)) Insignificant (direct effects (uptake)- shellfish (brooding Crustacea))
	Potential impacts on fish and shellfish due to changes in water quality (due to fine sediment plume and fine sand dispersion) (direct and indirect effects) (Section 9.3.2)	Insignificant (elevated SSC – finfish and general shellfish assemblage (excluding brooding Crustacea)) Insignificant (elevated SSC – shellfish (brooding Crustacea)) Insignificant (organic enrichment and oxygen depletion) Insignificant (release of contaminants)	Best practice procedures (Section 3.5)	Insignificant (elevated SSC – finfish and general shellfish assemblage (excluding brooding Crustacea)) Insignificant (elevated SSC – shellfish (brooding Crustacea)) Insignificant (organic enrichment and oxygen depletion) Insignificant (release of contaminants)
	Potential impacts to fish and shellfish due to noise, vibration and lighting (Section 9.3.3)	Insignificant	Best practice procedures (Section 3.5)	Insignificant
	Sandeel assessment (Section 9.3.4)	Insignificant (habitat change (structure/habitat) due to seabed removal and screening)	Best practice procedures (Section 3.5)	Insignificant (habitat change (structure/habitat) due to seabed removal and screening)

Receptor	Potential Impact Pathway	Impact Significance	Mitigation	Residual Impact
		Insignificant to minor adverse (direct removal of sandeel/entrainment by the dredger draghead)		Insignificant to minor adverse (direct removal of sandeel/entrainment by the dredger draghead)
	Herring assessment (Section 9.3.5)	Insignificant (egg entrainment by the dredger draghead) Insignificant to minor adverse (habitat change (structure / habitat) due to seabed removal) Insignificant (habitat change due to fining of suitable habitat (PIZ and SIZ) (incorporating recovery of habitat)) Insignificant (Egg smothering (plume, sediment mobilisation, sand settlement) (SIZ))	Best practice procedures (Section 3.5)	
Marine and Coastal Ornithology	Potential indirect effects on waterbirds and marine birds as a result of seabed removal (Section 10.3.1)	Insignificant (waterbirds) Insignificant (marine birds)	No specific mitigation required.	Insignificant (waterbirds) Insignificant (marine birds)
	Potential impacts on the foraging of marine birds due to suspended sediment plumes (Section 10.3.2)	Insignificant	No specific mitigation required.	Insignificant
	Potential impacts on the foraging of waterbirds due to fine sand dispersion (including bedform) (Section 10.3.3)	Insignificant	No specific mitigation required.	Insignificant
	Potential impacts of disturbance generated by vessel presence on waterbirds and marine birds (including visual, noise and vibration) (Section 10.3.4).	Insignificant	No specific mitigation required.	Insignificant
Marine Mammals and Turtles	Potential impacts to marine mammals due to the removal of seabed (Section 11.3.1)	Insignificant	No specific mitigation required.	Insignificant
	Potential impacts to marine mammals from reduced water clarity due to the suspended sediment plume (Section 11.3.2)	Insignificant	No specific mitigation required.	Insignificant
	Potential disturbance to marine mammals due to the noise and vibration effects (Section 11.3.3)	Insignificant	No specific mitigation required.	Insignificant
	Potential collision risk to marine mammals due to vessel movements (Section 11.3.4)	Insignificant	No specific mitigation required.	Insignificant
Commercial and Recreational Fisheries	Disruption of fisheries activities due to dredger movements (Section 12.3.1)	Insignificant (commercial fisheries)	No specific mitigation required.	Insignificant

Receptor	Potential Impact Pathway	Impact Significance	Mitigation	Residual Impact
		Insignificant (recreational fisheries)		
	Damage to fishing gear (Section 12.3.2)	Insignificant (commercial fisheries) Insignificant (recreational fisheries)	No specific mitigation required.	Insignificant
	Indirect impacts on target fish and shellfish stocks (Section 12.3.3)	Insignificant (commercial fisheries) Insignificant (recreational fisheries)	No specific mitigation required.	Insignificant
Commercial and Recreational Navigation	Aggregate dredger accident or incident at Bedwyn Sands and NMG (Section 13.3.1)	Minor adverse	Risk reduction measures in existing BMAPA/MCA good practice guide (Section 13.3)	Minor adverse
	Aggregate dredger accident or incident whilst on passage between Bedwyn Sands and NMG and berth (Section 13.3.2)	Minor adverse	Risk reduction measures in existing BMAPA/MCA good practice guide (Section 13.3)	Minor adverse
	Displacement of vessels out of Bedwyn Sands and NMG (Section 13.3.3)	Minor adverse	Risk reduction measures in existing BMAPA/MCA good practice guide (Section 13.3)	Minor adverse
	Water quality impacts resulting from accidents, incidents or spillages (Section 13.3.4)	Minor adverse	Risk reduction measures in existing BMAPA/MCA good practice guide (Section 13.3)	Minor adverse
Marine Archaeology	Direct damage to the marine archaeological resource (Section 14.3.2)	Insignificant (known receptors) Major adverse (unknown receptors)	Exclusion zones, Marine Aggregate Industry (MAI) Protocol for unknown assets (Section 14.3)	Insignificant (known receptors) Minor adverse (unknown receptors)
	Indirect damage to the marine archaeological resource (Section 14.3.3)	Insignificant	Future monitoring assessment (Section 14.3)	Insignificant
Coastal Protection and Flood Defence	Potential for maintaining source of aggregate for coastal defences and beach nourishment (Section 15.3.1)	Minor beneficial	No specific mitigation required.	Minor beneficial
	Potential for changes to wave height/exposure to affect coastal protection/flood defence (Section 15.3.2)	Insignificant	No specific mitigation required.	Insignificant
Air quality	Potential for change in air quality due to aggregate dredger emissions (Section 16.3.1)	Insignificant	No specific mitigation required.	Insignificant
Infrastructure and Other Existing Marine Users	Potential impacts of physical processes changes on marine and land-based infrastructure (Section 17.3.1)	Insignificant	No specific mitigation required.	Insignificant
Human Health	Potential impacts on human health related to quality and noise/light pollution (Section 18.3.1)	Insignificant	No specific mitigation required.	Insignificant
Cumulative and in-combination effects	Potential cumulative/in-combination effects for each receptor (Section 19.4)	Insignificant	No specific mitigation required.	Insignificant

20.2 Monitoring proposals

Pre-dredge and operational monitoring proposals are outlined below. Please note that a monitoring programme would be required by the licence conditions, following common industry practice and up to date requirements of the MMO/NRW and their advisors (based on standard licence conditions).

20.2.1 Baseline/pre-dredge monitoring

In compiling this ES, sufficient baseline information was generally available to be able to undertake a robust assessment of impacts. Given that licensed aggregate extraction operations are currently underway at Bedwyn Sands and Area 455/459, it is proposed that the existing baseline datasets are maintained for use in future monitoring studies, with analysis compared against each datasets collected in the interim period. In this way, the full set of annual survey data, collected across the extraction sites since 2008, will be maintained as an ongoing record of the historic and contemporary variability in the character of the wider Middle and Welsh Grounds (prior to, and since, commencement of extraction activities. Survey data collected during 2022 is currently being analysed and reported in the latest Annual Monitoring Report, whilst repeat surveys for 2023 are also scheduled/ underway.

20.2.2 Operational monitoring

It is proposed that the operational monitoring programme continues to follow that which is currently in place for each of the two extraction sites (Bedwyn and Area 455/459). This is summarised in Section 3.5.1 and is detailed further in the most recent Annual Monitoring Report (ABPmer, 2022).

Building on the breadth of existing baseline and annual monitoring data already collected in support of the existing, ongoing extraction activities, it is proposed that the future operational monitoring programme continues to collect the following:

- Annual offshore bathymetry data across the extraction sites and the wider Middle and Welsh Grounds (repeating the annual surveys collected since 2008 and, most recently, in 2023);
- Analysis of the offshore bathymetry against the agreed metrics (i.e. height, area and volume of the offshore resource), as reported in ABPmer, 2022;
- Collection of annual LiDAR data across the study foreshore, for subsequent analysis should the offshore bathymetry reveal an 'Amber' or 'Red' outcome;
- Seabed grab samples collected in line with the RSMP approach (coverage and frequency over the renewal period to be agreed with Cefas during Year 1 of the new licenses), with subsequent analysis of particle size distribution (PSD) and macrobenthos;
- Annual reporting to include analysis of the wider regional Middle and Welsh Grounds as well as the established study areas associated with each of the extraction areas;
- Monitoring data analysed to provide updated resource thickness maps across each of the licensed areas; and
- 5-year substantive reviews of the annual monitoring survey data undertaken at 5-year intervals throughout the licence period.

The frequency of these surveys would be reviewed based on the results of the substantive reviews which would take place every five years during dredging operations. Reporting would generally be anticipated within nine months of surveys being undertaken, with analysis including a comparison with previous datasets. A new resource assessment will be produced each time new bathymetric data are reported in order to ensure that an adequate layer of resource remains on the seabed.

As well as the sediment monitoring undertaken through the RSMP approach, the PSD analysis of the cargoes taken off each Area will also be undertaken and reported on in the regular annual monitoring reports (related to the review of the morphological conditions, see above), with highlighting of any noticeable changes in the particle size.

20.3 References

ABPmer (2022) Bedwyn Sands and North Middle Ground: 5-year substantive review, ABPmer Report No. R.3836, for Severn Sands Ltd., November 2022.

21 Conclusions

Best practice procedures and mitigation measures already undertaken by the UK marine aggregate industry will contribute to avoiding and/or minimising environmental impacts where possible as a result of continued dredging at Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459). Consultation with key stakeholders has been undertaken prior to and throughout the assessment, to identify potential problem areas and possible solutions. This was valuable for confirming that the scheme will have the lowest environmental impact of any available alternative.

The majority of impacts identified in this ES have been assessed to be insignificant or minor adverse (not significant). Where the potential for moderate or major adverse impacts has been identified, the mitigation measures listed within Section 20 are considered sufficient to reduce the residual impact significance to minor adverse at worst.

22 Abbreviations/Acronyms

14C	Carbon-14
3H	Tritium
AA	Appropriate Assessment
AA	Annual Average
ABP	Associated British Ports
ACC	Access
ADA	Active Dredge Area
AEOI	Adverse Effect On Site Integrity
AEZ	Archaeological Exclusion Zone
AGG	Aggregates
AIR	Air (Quality)
AIS	Automatic Identification System
AL	Action Level
ALARP	As Low As Reasonably Practicable
ALSF	Aggregate Levy Sustainability Fund
ANSI	American National Standards Institute
AONB	Areas of Outstanding Natural Beauty
AQ	Aquaculture
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AQU	Aquaculture
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
ASEA	Avonmouth Severnside Enterprise Area
ASERA	Association of Severn Estuary Relevant Authorities
AWB	Artificial Water Body
BACs	Background Assessment Concentrations
BAP	Biodiversity Action Plan
BCMA	Bristol Channel Marine Aggregates
BDPE	Brominated Diphenylether
BDSCT	Bristol Deep Sea Container Terminal
BEEMS	British Energy Estuarine and Marine Studies
BEIS	Business, Energy & Industrial Strategy
BGS	British Geological Survey
BIO	Biodiversity
BMAPA	British Marine Aggregate Producers Association
BP	Before Present
BPC	Bristol Port Company
BSS	Bed Shear Stress
BTO	British Trust of Ornithology
BWD	Bathing Waters Directive
BWMC	Ballast Water Management Convention
CA	California
CAB	Cables
Cadw	Welsh Government's Historic Environment Service
CBA	Council for British Archaeology
CBC	Cross-Border Co-operation
CBD	Convention on Biological Diversity

CBN	Continuous Broadband Noise
CC	Climate Change
CCC	Committee on Climate Change
CCGT	Combined Cycle Gas Turbines
CCO	Channel Coastal Observatory
CCW	Countryside Council for Wales
CD	Chart Datum
CE	Cumulative Effects
CEDA	Central Dredging Association
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMEX	CEMEX UK Marine Ltd.
CI	Confidence Interval
CIA	Cumulative Impact Assessments
CIEEM	Charted Institute of Ecology and Environmental Management
CIfA	Chartered Institute for Archaeologists
CIS	Coastal Impact Study
CO_2	Carbon Dioxide
COLREGS	International Regulations for the Prevention of Collision at Sea
COWRIE	Collaborative Offshore Wind Research into the Environment
C-POD	Passive acoustic monitoring system for porpoises, dolphins and other toothed whales
CROW	Countryside and Rights of Way
cSAC	candidate Special Area of Conservation
CSIP	Cetacean Strandings Investigation Programme
CSM	Common Standards Monitoring
CV	Coefficient of Variation
D&S IFCA	Devon & Severn IFCA
dB	Decibel
DBA	Desk Based Assessment
DC	District of Columbia
DCLG	Department for Communities and Local Government
DCO	Development Consent Order
DD	Dredging and Disposal
DECC	Department of Energy and Climate Change
DEF	Defence
Defra	Department for Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DFO	Fisheries and Oceans Canada
DfT	Department for Transport
DIST	Disturbance
DO	Dissolved Oxygen
DOER	Dredging Operations and Environmental Research
DONG	DONG Energy
DS	Data Services
DSIFCA	Devon and Severn Inshore Fisheries and Conservation Authority
dw	Dry Weight
DWT	Deadweight Tonnage
EA	Environment Agency
EACs	Environmental Assessment Criteria
EC	European Commission or European Community
ECON	Economic
EDF	Électricité de France
EEC	European Economic Community

EIA	Environmental Impact Assessment
EL	Environmental Laboratory
ELC	Energy Low Carbon
EMP	Employment
EMS	European Marine Site
ENV	Environment
EPS	European Protected Species
EQS	Environmental Quality Standard
EQSD	Environmental Quality Standards Directive
ER	Estuarine Residents
ERDC	Engineer Research and Development Center
ES	Environmental Statement
ESAS	European Seabirds at Sea
ETM	Estuarine Turbidity Maximum
ETSU	Energy Technology Support Unit
EU	European Union
EUBS	EU Biodiversity Strategy
EUR-Lex	Official website of European Union law documents
FIS	Fisheries
FISH	Fishing
FM	Flexible Mesh
FRMP	Flood Risk Management Plan
GB	Great Britain
GBP	British Pound
GCS	Good Chemical Status
GE	General Electric
GEN	General
GEP	Good Ecological Potential
GES	Good Ecological Status (WFD) / Good Environmental Status (MSFD)
GGAT	Glamorgan-Gwent Archaeological Trust
GHG	Greenhouse Gas
GHT	Gloucester Harbour Trustees
GIS	Geographic Information System
GOV	Government
GQA	General Quality Assessment
GS	Good Status
GT	Gross Tonnage
ha	Hectare
HAB	Habitat
HABSCORE	System of salmonid stream habitat measurement and evaluation
HAM	Hanson Aggregates Marine Ltd
HAT	Highest Astronomic Tide
HD	Hydrodynamic
HER	Historic Environment Record
HF	High-frequency
HM	Her Majesty's
Hmax	Maximum Wave Height
HMSO	His Majesty's Stationery Office
HMWB	Heavily Modified Water Body
HPMA	Highly Protected Marine Area
HRA	Habitats Regulations Appraisal
HRW	HR Wallingford Ltd

HSC	Historic Seascape Characterisation
Hs	Significant Wave Height
HW	High Water
IAMMWG	Inter-Agency Marine Mammal Working Group
IAS	Invasive Alien Species
IBN	Impulsive Broadband Noise
ICES	International Council for the Exploration of the Sea
ID	Identity
IECS	Institute of Estuarine and Coastal Studies
IEMA	Institute of Environmental Management and Assessment
IFCA	Inshore Fisheries and Conservation Authorities
iMADP	interim Marine Aggregates Dredging Policy
INCA	Industry Nature Conservation Association
INF	Infrastructure
INNS	Invasive Non-Native Species
INS	Information Navigation Services
INTERREG	A European territorial cooperation programme that is connected to the European Regional Development Fund (ERDF)
IROPI	Imperative Reasons of Overriding Public Interest
ISBN	International Standard Book Number
ISO	International Organization for Standardization
ISSN	International Standard Serial Number
IUCN	International Union for Conservation of Nature
iVMS	Inshore Vessel Monitoring System
JFS	Joint Fisheries Statement
JNCC	Joint Nature Conservation Committee
KWR	Kingsweston Rhine (watercourse)
LAQM	Local Air Quality Management
LAT	Lowest Astronomic Tide
LBAPs	Local Biodiversity Action Plan
LDP	Local Development Plan
LF	Low-Frequency
LiDAR	Light Detection and Ranging
LOA	Length Overall
Lrms	Mean-Square Sound Pressure Level
LS	Littoral Sediment
LSE	Likely Significant Effect
LUC	Land Use Consultants
μPa	micro Pascal
MA	Management Association
MAC	Maximum Allowable Concentration
MADP	Marine Aggregates Dredging Policy
MAGIC	Multi-Agency Geographic Information for the Countryside
MAI	Maritime Archaeology Impact
MAIB	Marine Accident Investigation Branch
MALSF	Marine Aggregate Levy Sustainability Fund
MAREA	Marine Aggregate Regional Environmental Assessment
MarESAs	Marine Evidence based Sensitivity Assessments
MarLIN	Marine Life Information Network
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MCZ	Marine Coastal Zone

MDO	Marine Diesel Oil
MEMG	Marine Environment Monitoring Group
MEPF	Marine Environment Protection Fund
MES	Marine Ecological Surveys
MF	Mid-Frequency
MFA	Marine and Fisheries Agency
MGO	Marine Gas Oil
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
ML	Marine Litter
MLA	Marine Licence Application
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Spring
MMD	Marine migrant dependent
MMMU	Marine Mammal Management Unit
MMO	Marine Management Organisation
MMR	Marine Monitoring Report
mN	metres North(ing)
MNCR	Marine Nature Conservation Review
MOD	Ministry of Defence
MPA	Marine Protected Area
MPS	Minerals Policy Statement
MS	Marine stragglers
MSFD	Marine Strategy Framework Directive
MSL	Mean Sea Level
MTAN	Minerals Technical Advice Note
MU	Management Units
MW	Megawatts
MWR	Marine Works (EIA) Regulations
NA	Not Applicable
NAO	North Atlantic Oscillation
NBN	National Biodiversity Network
NBSAP	National Biodiversity Strategy and Action Plan
NCEP	National Centers for Environmental Prediction
NDA	Nuclear Decommissioning Authority
NDFA	North Devon Fishermen's Association
NE	Natural England
NERC	Natural Environment and Rural Communities
NGOs	Non-Governmental Organisations
NHC	Newport Harbour Commissioners
NIFDL	National Inshore Fisheries Data Layer
NIS	Non-Indigenous Species
NMFS	National Marine Fisheries Service
nm	Nautical Mile
NMG	North Middle Ground
NMHR	National Marine Heritage Record
NMRW	National Monuments Record of Wales
NNRP	National Natural Resource Policy
NO_2	Nitrogen Oxide
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxide
NPPF	National Planning Policy Framework

NPRN	National Primary Record Number
NPWS	National Parks and Wildlife Service
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
NTS	Non-Technical Summary
NTSLF	National Tidal and Sea Level Facility
NVZs	Nitrate Vulnerable Zones
NW	North West
OASIS	Online AccesS to the Index of archaeological InvestigationS
ODPM	Office of the Deputy Prime Minster
OEL	Ocean Ecology Report
OESEA	Offshore Energy Strategic Environmental Assessment
OG	Oil and Gas
OHID	Office for Health Improvement and Disparities
ONS	Office for National Statistics
OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PIZ	Primary Impact Zone
PLC	Public Limited Company
PM	Particle Matter
PM10	Particulate Matter (10 microns or less)
PM2.5	Fine Particulate Matter (2.5 microns or less)
PPW	Planning Policy Wales
PS	Ports and Shipping
PSA	Particle Size Analysis
PSD	Particle Size Distribution
pSPA	proposed Special Protection Areas
psu	Practical Salinity Units
PTS	Permanent Threshold Shift
PW	Phocid Pinnipeds
QMS	Quality Management System
RAG	Regulatory Advisory Group
Ramsar	Wetlands of international importance, designated under The Convention on Wetlands (Ramsar, Iran, 1971)
RBD	River Basin District
RBMP	River Basin Management Plans
rBWD	revised Bathing Water Directive
RCAHMW	Royal Commission on the Ancient and Historical Monuments of Wales
REN	Renewable Energy
RIAA	Report to Inform the Appropriate Assessment
RIFE	Radioactivity in Food and the Environment
RMA	Resource Management Association
RMS	Root-Mean-Square
RNLI	Royal National Lifeboat Institute
RoRo	Roll-on, Roll-off
RPW	Royal Pier Waterfront
RSMP	Regional Seabed Monitoring Programme
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation

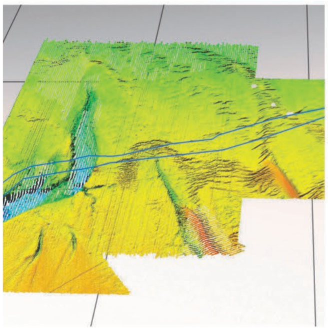
SAF	Safeguarding
SCANS	Small Cetacean Abundance in the European Atlantic and North Sea
SCC	Somerset County Council
SCI	Science
SCOS	Special Committee on Seals
SCP	Seascape
SEA	Strategic Environmental Assessment
SEAMAP	Marine habitat data product
SEAWG	Severn Estuary Aggregates Working Group
SECG	Severn Estuary Coastal Group
SEL	Sound Exposure Level
SELcum	Cumulative Sound Exposure Level
SEP	Severn Estuary Partnership
SFCs	Sea Fisheries Committees
SHA	Statutory Harbour Authority
SI	International System
SIZ	Secondary Impact Zone
SL	Source Level
SMP	Shoreline Management Plan
SMRU	Sea Mammal Research Unit
SMU	Seal Management Unit
SOC	Society
SoNaRR	State of Natural Resources Report
SOx	Sulphur Oxides
SPA	Special Protection Area
SPEEK	Study of Post-extraction Ecological Effects in the Kwintebank Sand Dredging Area
SPL	Sound Pressure Level
SRA	Strategic Resource Area
SSC	Suspended Sediment Concentration
SSSI	Sites of Special Scientific Interest
STP	Severn Tidal Power
SW	Spectral Wave
TANs	Technical Advice Notes
TBPC	The Bristol Port Company
TBT	Tributyltin
TCE	The Crown Estate
TE	Technical
TEZs	Temporary Exclusion Zones
THLS	Trinity House Lighthouse Service
TM	Tarmac Marine
TNO	Netherlands Organisation for Applied Scientific Research
TOS	Traffic Organisation Services
Tp	Peak Wave Period
TR	Technical Report
TRaC	Transitional and Coastal Waters
TS	Technical Statement
TSHD	Trailing Suction Hopper Dredger
TTS	Temporary Threshold Shift
Tz	Mean zero-Crossing Wave Period
UK	United Kingdom
UKCP	UK Climate change projections
UKHO	United Kingdom Hydrographic Office

UKHSA	UK Health Security Agency
UKMMAS	UK Marine Monitoring and Assessment Strategy Community
UKOOA	UK Offshore Operators Association
URS	United Research Services
USA	United States of America
UWN	Underwater Noise
UWWTD	Urban Waste-Water Treatment Directive
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMS	Vessel Monitoring System
VPA	Visual Prey Availability
VTS	Vessel Traffic Services
WACA	Wildlife and Countryside Act 1981
WBP	Wales Biodiversity Partnership
WBSB	Wales Biodiversity Strategy Board
WDCS	Whale and Dolphin Conservation Society
WeBS	Wetland Bird Survey
WEDA	Western Dredging Association
WFA	Welsh Fishermen's Association
WFD	Water Framework Directive
WFD-BI	WFD Bristol Channel Inner (Measurement Site)
WG	Welsh Government
WGMFD	Welsh Government Marine and Fisheries Division
WGS	World Geodetic System
WNMP	Welsh National Marine Plan
WODA	World Organization of Dredging Associations
WQ	Water Quality
WW	World War
WWT	Wildfowl and Wetlands Trust

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices


Innovative Thinking - Sustainable Solutions

A Consultation

A.1 Introduction

This appendix contains the following information / documentation on consultation to date:

- Summaries of how each of the comments raised in the Scoping Opinions from the Marine Management Organisation (MMO) and Natural Resources Wales (NRW) have been addressed are presented in Table A-1 and Table A-2 respectively; and
- Details of the wider consultation are provided in Table A-3.

Prior to receipt of the formal scoping opinions, two regulator meetings also took place, one on 12 April 2022 with NRW and one on 9 May 2022 with the MMO its advisors to begin early discussion on renewal options for Bedwyn Sands and North Middle Ground (NMG).

A.2 Summary of Comments Addressed

Table A-1 Consultation log for MMO Scoping Opinion

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
Conservation of Habitats and Species Regulations 2017	The development site is within the following internationally designated nature conservation sites: ▪ Severn Estuary / Môr Hafren Special Area of Conservation (SAC) ▪ Severn Estuary / Môr Hafren Special Area of Protection (SPA) Severn Estuary / Môr Hafren Wetland of International Importance under the Ramsar Convention (Ramsar Site) ▪ River Usk SAC ▪ River Wye SAC	Noted and taken account of in the Environmental Statement (ES) and Habitats Regulations Assessment (HRA).	Sections 7 to 10, Appendix C
	The ES should thoroughly assess the potential for the proposal to affect Internationally designated sites (e.g. designated Special Areas of Conservation (SAC) and Special Protection Areas (SPA)). These fall within the scope of the Conservation of Habitats and Species Regulations 2017 (as amended). In addition paragraph 176 of the National Planning Policy Framework requires that potential Special Protection Areas, possible Special Areas of Conservation, listed or proposed Ramsar sites, and any site identified as being necessary to compensate for adverse impacts on classified, potential or possible SPAs, SACs and Ramsar sites be treated in the same way as classified sites.	Noted and taken account of in the ES and HRA.	Sections 7 to 10, Appendix C
	Under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) an appropriate assessment needs to be undertaken in respect of any plan or project which is (a) likely to have a significant effect on a European site (either alone or in combination with other plans or projects) and (b) not directly connected with or necessary to the management of the site.	Noted and taken account of in the HRA.	Appendix C
	Further information on the special interest features, their conservation objectives, and any relevant conservation advice packages for designated sites is available on the Natural England (NE) website: https://designatedsites.naturalengland.org.uk/	Noted and taken account of in the HRA.	Appendix C

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	The ES should include a full assessment of the direct and indirect effects of the development on the features of special interest within the designated sites, and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects.	Noted and taken account of in the ES and HRA.	Sections 7 to 10, Appendix C
	It is noted that there is no consideration of the implications of sediment material itself being removed as aggregate. The sediment being removed is protected in its own right as being part of the subtidal sandbanks feature of the Severn Estuary SAC. While the amount of material being removed and its associated impacts of the sediment's removal on the communities present etc has been considered, the assessment has not included the implications of removing the material itself and what proportion of the resource in the vicinity this constitutes. An assessment of this aspect should be included in the ES and EIA.	This is considered as part of the assessment against "*no decrease in extent*" attribute/targets for the subtidal sandbanks feature in the HRA which is included in the ES.	Appendix C
	The MMO advises that further evidence is required regarding Marine Mammals. When assessing for impacts on marine mammals Natural Resources Wales (NRW) have recommended using the Welsh Marine Mammal Management Units (MMMU), as outlined in NRW's position on the use of Marine Mammal Management Units for screening and assessment in HRAs for SACs with marine mammal features (NRW, 2022). NRW have also recommended making use of the Welsh Marine Mammal Atlas to source density values, as the density maps are composed of 30 years of sightings data. NRW have informed the MMO that they would be happy to discuss forwarding copies of the required maps (official sensitive, and not for circulation), and to provide density values following agreement on an area of search.	MMMUs has informed the screening and assessment stages of the HRA. A range of data sources have been used to support the marine mammal impact assessment.	Section 11.1, Appendix C
	For the assessment of Likelihood of Significant Effects (LSE) test, the nearest SACs designated for grey seal and harbour porpoise (Bristol Channel Approaches SAC designated for Harbour porpoise, and Pembrokeshire Marine SAC designated for grey seal), are assessed due to their proximity to the project area, and the project area being within the Management Unit (MU) for both species. An iterative assessment should be carried out, where if no LSE is concluded for the nearest SAC, a conclusion of no LSE can also be made for more distance SACs within the MU.	Noted and taken account of in the HRA.	Appendix C

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	Based on the information presented there is potential for the proposal to have a possible significant effect on marine mammals regarding underwater noise and prey species given its proximity to the Bristol Channel Approaches SAC. Therefore we suggest that the proposal is taken through an appropriate assessment to include all relevant information in the report.	Information to support an AA is included in the HRA.	Appendix C
	The MMO advise that the Habitats Regulations Assessment (HRA) considers the effect of the dredging on diadromous fish features and sub-features of the Severn Estuary SAC and Ramsar site, River Usk SAC and River Wye SAC.	These fish features are considered in the HRA.	Appendix C
Other Nature Conservation	The development site is within the following nationally designated nature conservation site: Severn Estuary / Môr Hafren Site of Special Scientific Interest (SSSI)	Noted and taken into account in the ES.	Section 7
	Further information on the location of SSSIs and their special interest features can be found at www.magic.gov.uk. The ES should include a full assessment of the direct and indirect effects of the development on the features of special interest within this site and should identify such mitigation measures as may be required in order to avoid, minimise or reduce any adverse significant effects	Noted and taken into account in the ES.	Sections 7 to 8
	The EIA will need to consider any impacts upon local wildlife and geological sites. Local Sites are identified by the local wildlife trust, geoconservation group or a local forum established for the purposes of identifying and selecting local sites. They are of county importance for wildlife or geodiversity. The ES should therefore include an assessment of the likely impacts on the wildlife and geodiversity interests of such sites. The assessment should include proposals for mitigation of any impacts and if appropriate, compensation measures. Contact the local wildlife trust, geoconservation group or local sites body in this area for further information.	Noted and taken into account in the ES.	Section 7
	For species protected by the Wildlife and Countryside Act 1981 (as amended) and by the Conservation of Habitats and Species Regulations 2017 (as amended), the ES should assess the impact of all phases of the proposal on protected species (including, for example, pinnipeds (seals), cetaceans (including dolphins, porpoises whales), fish (including seahorses, sharks and skates), marine turtles, birds, marine invertebrates, bats, etc.).	The effects on protected species have been assessed in the ES.	Section 7 to 10

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	Information on the relevant legislation protecting these species can be reviewed on the following link https://www.gov.uk/government/publications/protected-marine-species.	Noted and taken account of in the ES.	Appendix B.2.5
	The MMO, in consultation with NE, recognises the acknowledgement of the benthic characteristics at the aggregate extraction points however we advise that the following statements are also considered in the ES and EIA: • Description of benthic communities present within and adjacent to a project area, including described biotopes, covering biodiversity, function, abundance, extent, species richness, representativeness, rarity and sensitivity. This should cover the range of water depths across a site and include both infaunal and epifaunal communities. • Identification of any invasive non-native species (INNS) and species non-native to UK waters. Information should also be Page 8 of 18 provided on species non-native to the local habitat types (e.g. hard-substrate specialists in a wider sedimentary habitat).	Noted and taken account of in the ES.	Sections 8, 9
	NE does not hold comprehensive information regarding the locations of species protected by law, but they do advise on the procedures and legislation relevant to such species. Records of protected species should be sought from appropriate local biological record centres, nature conservation organisations, NBN Atlas, groups and individuals; and consideration should be given to the wider context of the site for example in terms of habitat linkages and protected species populations in the wider area, to assist in the impact assessment.	Recognised and relevant data sources and organisations have been consulted.	Sections 7, 8
	The conservation of species protected by law is explained in Part IV and Annex A of Government Circular 06/2005 Biodiversity and Geological Conservation: Statutory Obligations and their Impact within the Planning System. The area likely to be affected by the proposal should be thoroughly surveyed by competent ecologists at appropriate times of year for relevant species and the survey results, impact assessments and appropriate accompanying mitigation strategies included as part of the ES. In order to provide this information there may be a requirement for a survey at a particular time of year. Surveys should always be carried out in optimal survey time periods and to current guidance by suitably qualified and where necessary, licensed, consultants.	The relevant data sources and surveys that have been carried out are detailed in the relevant receptor chapters of the ES.	Sections 8 to 11

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	The ES should thoroughly assess the impact of the proposals on habitats and/or species listed as 'Habitats and Species of Principal Importance' within the England Biodiversity List, published under the requirements of S41 of the Natural Environment and Rural Communities (NERC) Act 2006. Section 40 of the NERC Act 2006 places a general duty on all public authorities, including local planning authorities, to conserve and enhance biodiversity. Further information on this duty is available here: https://www.gov.uk/guidance/biodiversity-duty-public-authority-duty-to-have-regardto-conserving-biodiversity.	Relevant NERC habitats and species have been taken account of in ES.	Sections 7 to 11, Appendix A.3
	Government Circular 06/2005 states that Biodiversity Action Plan (BAP) species and habitats, 'are capable of being a material consideration…in the making of planning decisions'. The MMO, in consultation with NE, therefore advises that survey, impact assessment and mitigation proposals for Habitats and Species of Principal Importance should be included in the ES. Consideration should also be given to those species and habitats included in the relevant Local BAP.	The relevant data sources and surveys that have been carried out are detailed in the relevant receptor chapters of the ES.	Sections 8 to 11
	The development should seek if possible to avoid adverse impact on sensitive areas for wildlife within the site, and if possible provide opportunities for overall wildlife gain. The record centre for the relevant Local Authorities should be able to provide the relevant information on the location and type of priority habitat for the area under consideration.	Mitigation has been detailed fully in relevant assessment chapters of the ES.	Sections 8 to 11
	Presence of INNS in the Severn Estuary including priority species on the high risk monitoring and surveillance list for Wales, means that viable Page 9 of 18 INNS pathways exist in this area, which includes the transfer of hopper water as a result of dredging activities, directly relevant to the current application. This should be addressed in the revised version of the biosecurity risk assessment submitted as part of the final proposal. The MMO advise that a draft version is submitted with the EIA.	Potential impacts through the introduction and spread of INNS have been assessed in the ES.	Section 8.3.6
	The MMO do not consider that the following species are established in the Severn Estuary – *Crepidula fornicata*, *Magallana gigas*, *Hemigrapsus sanguineus*. It is also worth noting that the Chinese mitten crab *Eriocheir sinensis* has also been recorded in the Severn Estuary and should be considered as part of the biosecurity risk assessment.	INNS are characterised in the ES.	Section 8

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	The MMO advises that hopper washing may be required depending on where the hopper dredger is transiting from/to at the start and end of each campaign. This should be addressed as part of the biosecurity risk assessment.	No hopper washing is proposed.	Section 3.3
	There is a lack of consideration given to the Annex I habitats, particularly H1110 within the Severn Estuary SAC. The objectives for feature H1110 include the maintenance of the variety and distribution of sediment types across the feature, and the maintenance of the gross morphology of the feature (including its depth and profile). By the nature of the aggregate extraction process, these objectives will be directly impacted. As such, these should be considered within the ES.	Annex I habitats have been considered in the ES and HRA.	Sections 7, 8, Appendix C
Benthic Ecology	The MMO note the proposal to use the survey data collected (Fauna and Sediment) as part of the Regional Seabed Monitoring Programme (RSMP) in both dredging areas since 2017. This data source is suitable evidence for the Benthic Ecology characterisation and for the EIA.	The full list of data sources are detailed in the relevant chapter.	Section 8.1.1
	The list of the potential aggregate dredging impact pathways scoped as described in Section 5.4.3 of the report are suitable to investigate the potential impact of dredging at the Bedwyn Sands and NMG extraction areas.	These impact pathways have now been assessed in the ES.	Section 8.3
	The Benthic Ecology monitoring was undertaken at the Bedwyn Sands and NMG areas as part of the RSMP since 2017. It is not clearly stated in the scoping report whether this will be continued if the Marine Licences were to be renewed, however, it is strongly recommended as best practice for the aggregate industry.	The RSMP is proposed to be continued as best practice.	Section 20
	Benthic Ecology has been scoped in the report as one of the Marine Ecology topics but there are no details on what benthic receptors will be considered for the EIA (i.e. species, habitats). This is not expected at the scoping stage but should be identified as part of the benthic characterisation in the ES.	The baseline character and relevant receptors for this topic are described in the ES.	Section 8.2
Coastal Processes	The scoping is conducted at a high level and suggests that impacts on physical processes and water quality will be assessed. This should not simply be an extension of monitoring and reporting under the previous licence and, for a 15-year licence renewal, requires a comprehensive study of up to date and state of the art knowledge	Up to date assessment of physical processes effects has been	Section 5

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	- as such, more detailed presentation of environmental information in the proposed Coastal Impact Study (CIS) and ES will be required.	undertaken in the CIS and ES.	
	The MMO advise impacts to wave energy propagation are addressed as part of a physical processes chapter in the final ES, currently these impacts are covered as part of flood defence.	Effects on coastlines due to changes in wave conditions are assessed in the ES.	Section 5.4
	The impacts of potential sediment plumes to be assessed within the physical processes chapter of the ES should include extent and magnitude of potential sediment plumes relating to the proposed zone of influence.	Impacts of sediment plumes are assessed in the water and sediment quality chapter of the ES.	Section 6.3
Fish Ecology and Fisheries	The data highlighted within the scoping report to enable understanding of the marine fish assemblage, and its use of the proposed/ current sites, are lacking. This includes Environment Agency Transitional and Coastal Waters fish survey (EA TRaC) data, which is based on limited sampling by specific netting types at locations far removed from the dredging sites.	A comprehensive and up to date list of data sources used is provided in the ES.	Section 9.1.1
	The sampling at these sites was also conducted on a single catch sample basis. Therefore, such sampling cannot adequately characterise the assemblage in the dredging area or its specific uses of the area. For example, the scoping report highlights that herring may spawn in the area and that this needs to be considered. However, the available data cannot show whether or to what extent herring may use the sites that are proposed for further dredging (due to the location, timing and type of sampling which by its nature cannot determine spawning habitat use in the specific area).	The limitations of the fish sampling methods and a specific herring assessment has been included in the ES.	Section 9
	The MMO recommend further investigation of the use of the site as a spawning ground. Previous surveys for spawning grounds have not investigated this far into the Bristol Channel or Severn Estuary, so it would be inappropriate to rely on such data (e.g. spawning ground assessments by Ellis *et al*., 2012).	The latest available information on spawning grounds is detailed in the ES chapter.	Section 9.1.1

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	Similarly, juvenile cod (known locally as codling) are abundant in the estuary in the winter months and are thought to belong to a Bristol Channel/ Eastern Celtic Sea stock. This is not captured in the Ellis *et al*. (2012) report, probably because the underlying sampling does not take place in winter months when cod are abundant in the Severn Estuary.	The potential impacts on juvenile cod (codling) have been assessed.	Section 9.3
	Similarly, some fish surveys were carried out at NMG in 1999–2000 which is problematic in terms of (a) the sampling frequency, (b) the age and contemporary relevance of the data, and (c) the lack of consideration of the potential effects of climate change on species' distributions and abundances. Updated investigations are therefore required. Additionally, because many of the fish species will move in and out of the estuary, seasonally, in relation to food supply and according to tides, many more fish may transition through the dredged areas than use it habitually or for a specific function. Further sampling should therefore account for such temporal variation.	The assessment has been based on a range of available data sources, the limitations of which are taken account of in the assessment, in terms of levels of uncertainty and overall confidence.	Section 9
	Genetic data (Davies *et al*., 2020) highlight that there are likely to be localised genetically discrete populations of herring in the Severn, which are distinct from nearby populations. It is therefore possible that disturbance of the spawning grounds of these populations could result in localised depletion that cannot be compensated by an influx from other populations. This warrants further investigation, including of substrate suitability for spawning and use by herring.	An industry wide approach has been adopted specifically for the assessment of herring.	Section 9.3.5
	While the scoping report is expected to be high level given the stage of the application, the MMO notes that several important fish receptors have not been included.	A detailed baseline characterisation of fish and shellfish has been undertaken.	Section 9.2
	Tope, smoothound, thornback ray, lesser spotted dogfish and spotted ray are all known to inhabit the Bristol Channel, and small-eyed ray and blonde ray feed are found on sand banks within the Bristol Channel, as such consideration should be given to elasmobranchs in the ES.	Elasmobranchs have been considered in the ES.	Section 9
	The Bristol Channel and Severn Estuary represent nursery grounds for several species of commercial important fin-fish, including whiting, plaice, dab, flounder, sole and	Fish nursery grounds have been	Section 9

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	European seabass. In addition to these, thornback rays and blonde rays are also likely to have nursery grounds in the area and this should be suitably reflected in the ES.	characterised and considered in the ES.	
	Sandeel are only mentioned briefly in the characterisation of fish receptors in the existing environment. There are important spawning grounds for sandeels in the Bristol Channel and there are indications that sandeels have a high level of site fidelity and are not successful recolonisers (Jensen *et al.*, 2011), although young sandeel may display short term patch fidelity (Haynes & Robinson, 2011). Sandeels inhabit sediments and are present in the water column during the day but lie dormant in the sediment during their winter hibernation and spawning season (November – February, inclusive), (Beherns *et al.*, 2007, Greenstreet *et al.*, 2010). As such sandeel will be more vulnerable to habitat loss from physical disturbance of the seabed and uptake by dredgers during this period. Sandeels generally spawn where they are found; meaning that nursery grounds are typically located in the vicinity of spawning grounds.	A specific assessment of sandeel following an industry wide approach has been adopted in the ES.	Section 9.3.4
	As there may be sandeel populations in the vicinity of the aggregate area, the MMO recommends that a sandeel habitat suitability assessment be conducted following the method described by MarineSpace (2013) to assess the extent and significance of potential sandeel habitat. This method uses a suite of data sources to assign a 'heat' or confidence score to areas of habitat which have the potential to support sandeel. A further potential source of data and information on sandeel in this area of the Bristol Channel that could be useful to inform the ES is the 'Sandeel Supplementary Report to Inform Appropriate Assessment' (MarineSpace 2021) as this method uses a suite of data sources to assign a 'heat' or confidence score to areas of habitat which have the potential to support sandeel. This report was undertaken to support a marine licence application for Area 531 'North Bristol Deep' (Ref: MLA/2019/00448 Licence: L/2021/00111/1). A copy of this report may be available from the marine licence holders; Hanson Aggregates Marine Limited and Tarmac Marine Limited.	These data sources, including the Area 531 ES, have been taken account of in the sandeel assessment.	Section 9.3.4
	The sources proposed to inform the EIA are presented in Table 7 of the scoping report. Sources identified include "Cefas nursery and spawning grounds reports and data layers" which is assumed means Ellis *et al.*, (2012), which is suitable, although the limitations of the data should be acknowledged as spawning and nursery ground	Limitations of data sources are understood and	Section 9

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	data are limited for the inner Bristol Channel and Severn Estuary. Generally, the sources identified are appropriate, and the MMO supports the intention to consult with local fisheries stakeholders, including the Devon and Severn Inshore Fisheries and Conservation Authority (IFCA), and Welsh Fishermen's Association.	acknowledged in the assessment.	
	The scoping report states that data from annual monitoring undertaken as part of the industry-wide RSMP, will be used to characterise the composition of seabed sediments. The RSMP approach to monitoring includes the periodic collection of seabed sediments to identify any benthic macrofaunal and physical changes to the seabed during the term of the licence. Whilst the MMO supports the use of RSMP data for the purposes of monitoring changes to sediment composition during the term of the licence, we recommend that site-specific seabed sediment samples are collected across the primary impact zones (PIZ) and secondary impact zones (SIZ) of Areas 455 and 459 to support the characterisation of the environment for fish in the ES and to establish baseline conditions. Particle size analysis (PSA) data can then be used to determine whether the proposed licence areas are suitable as sandeel habitat following the MarineSpace (2013) method.	PSA data has been used to support the sandeel assessment.	Section 9.3.4
	No modelled data has been presented in relation to fish and fish ecology within the scoping report. However, given that screening activities are proposed, the MMO would expect that, as standard, plume dispersion modelling is presented in order to determine how dredging and screening activities are likely to effect sediment composition of the bedforms within the PIZ and SIZ, and to support conclusions made with regard to potential impacts to changes in water quality.	Assessment has been informed by Coastal Impact Study (CIS) modelling and other modelling work on general plume extents.	Sections 6.3.1, 9.3
Shellfish	The scoping report proposes to use the Countryside Council for Wales (CCW) Severn Estuary Fish Review; Cefas nursery and spawning grounds reports and data layers; most recent EA / NRW transitional and coastal (TraC) fish surveys; Cefas trawl surveys; Severn Tidal Power SEA. These are unlikely to provide abundance information for shellfish as they are targeted to fish but can provide presence/absence information. No reference was provided, but the CCW Severn Estuary Fish Review is from 2009. The MMO would expect more recent evidence to be used in the ES.	A comprehensive and up to date list of data sources used is provided in the ES.	Section 9.1.1

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	The scoping report states that the intention to use the nearby licence Area 531 ES to inform the Bedwyn Sands and NMG ES, however, no reference is provided for this evidence. Therefore, the MMO is currently unable to assess whether it is suitable to characterise shellfisheries.	A comprehensive and up to date list of data sources used is provided in the ES.	Section 9.1.1
Archaeology /Cultural Heritage	Given the outlined inclusion of marine archaeology as a material consideration, the MMO understand a desked based assessment (DBA) will be commissioned to inform the EIA, with the DBA completed by a registered organisation of the Chartered Institute for Archaeologists (CIfA). In doing so, we also note the range of sources proposed to support the DBA's publication – as outlined in Section 5.7.4 'Further work required for EIA', and it may be beneficial for the archaeological contractor to consider the coverage, quality and techniques of geophysical survey data previously acquired for monitoring purposes.	A DBA has been undertaken in support of the ES.	Appendix F
	The MMO note that a cumulative and in-combination assessment will be conducted to address known developments and activities occurring in the wider regional context to assess the potential impacts upon the historic environment. This is welcomed, as it is vital to ensure any future extraction of marine minerals in the region are only undertaken with full consideration of the potential for cumulative effects from dredging activities on the survival of archaeological sites, features and important deposits.	The cumulative and in-combination assessment has taken account of relevant marine archaeological receptors.	Section 19
	The ES must also include detail on the required mitigation and monitoring strategies to be adopted, with particular reference to the procedures detailed in the guidance published by the British Marine Aggregate Producers Association and English Heritage (2003), and to the 'Marine Aggregate Industry Protocol for the Discovery of Finds of Archaeological Interest' (2005), to ensure that they are in line with current industry standards.	Current industry standards have been followed in the assessment.	Section 14
	Any archaeological reports produced as a part of this development are to be recorded via OASIS (Online AccesS to the Index of archaeological InvestigationS).	Any reporting will be archived via OASIS.	Appendix F
Navigation /Other Users of the Sea	Navigational safety and mitigations should be discussed with the relevant statutory harbour authorities for the areas identified within the scoping document.	Further details on specific consultation undertaken for this	Sections 13, Table A-3 in Appendix A

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
		topic are provided in ES.	
	The MMO recommend the 'Guide to Good Practice for ensuring Navigation Safety during Dredging Operations' that has been formalised between the British Marine Aggregate Producers Association (BMAPA), MCA and Trinity House is adhered to. It is recognised by marine aggregate operators that a consistent approach is necessary to manage risks and minimise the potential impact on the navigation of other sea users. Such an approach has been endorsed by the Maritime and Coastguard Agency (MCA) and Trinity House Lighthouse Service (THLS).	Noted and acknowledged.	Section 13
Air Quality and Climate	The England Biodiversity Strategy published by Defra establishes principles for the consideration of biodiversity and the effects of climate change. The ES should reflect these principles and identify how the development's effects on the natural environment will be influenced by climate change, and how ecological networks will be maintained. The National Planning Policy Framework (NPPF) requires that the planning system should contribute to the enhancement of the natural environment 'by establishing coherent ecological networks that are more resilient to current and future pressures' (NPPF Para 174), which should be demonstrated through the ES.	The impacts of climate change have been taken account of in the ES.	Section 15.2.3, Appendix E
	Pollutants associated with combustion, particularly particulate matter and oxides of nitrogen are non-threshold; i.e., an exposed population is likely to be subject to potential harm at any level and that reducing public exposure to non-threshold pollutants (such as particulate matter and nitrogen dioxide) below air quality standards, will have potential public health benefits. This must be considered within the ES.	Air quality effects and potential consequences to human health are considered in the ES.	Sections 16, 18
	The MMO supports approaches which minimise or mitigate public exposure to non-threshold air pollutants, address inequalities (in exposure) and maximise co-benefits (such as physical exercise). The MMO encourage their consideration during development design, environmental and health impact assessment, and development consent.	Air quality effects and potential consequences to human health are considered in the ES.	Sections 16, 18
Water Quality	Increases in suspended sediment concentrations (SSC) during construction and operation have the potential to smother sensitive habitats. The ES should include information on the sediment quality and potential for any effects on water quality	These considerations have been taken account of the water	Sections 6, 7, 8, 9, 10 and 11 Appendix C

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	through suspension of contaminated sediments. The ES should also consider whether increased suspended sediment concentrations resulting are likely to impact upon the interest features and supporting habitats of the designated sites as listed above. The ES should consider whether there will be an increase in the pollution risk as a result of the construction or operation of the development.	and sediment quality assessment and HRA.	
	For activities in the marine environment up to 1 nautical mile out at sea, a Water Framework Directive (WFD) assessment is required as part of any application. The ES should draw upon and report on the WFD assessment considering the impact the proposed activity may have on the immediate water body and any linked water bodies. Further guidance on WFD assessments is available here: https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-andcoastal-waters	A WFD assessment has been undertaken and is included in the ES.	Appendix D
	The MMO would like to draw attention to errors made in the scoping report with regards to WFD classifications as an Environment Agency (EA) report from 2009 is referenced. Recent WFD information for the Severn Lower water body can be obtained from Water Watch Wales, showing the Severn Lower water body is at Moderate status for both Ecology and Chemicals. The MMO understands that the Severn River Basin Management Plan is due for release imminently.	A WFD assessment using the latest available information is included in the ES.	Appendix D
Population and Human Health	The MMO welcome the proposal to include a health section and believe the summation of relevant issues into a specific section of the report provides a focus which ensures that public health is given adequate consideration. The section should summarise key information, risk assessments, proposed mitigation measures, conclusions, and residual impacts, relating to human health. Compliance with the requirements of National Policy Statements and relevant guidance and standards should also be highlighted.	A human health assessment that is proportionate to the scale and nature of the proposed activities is included in the ES.	Section 18
	In terms of the level of detail to be included in the ES, the MMO recognise that the differing nature of projects is such that their impacts will vary. UK Health Security Agency (UKHSA) and The Office for Health Improvement and Disparities (OHID's) predecessor organisation Public Health England produced an advice document 'Advice on the content of Environmental Statements accompanying an application under the Nationally Significant Infrastructure Project (NSIP) Regime', setting out	A human health assessment that is proportionate to the scale and nature of the proposed	Section 18

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	aspects to be addressed within the ES. This advice document and its recommendations are still valid and should be considered when preparing an ES. Please note that where impacts relating to health and/or further assessments are scoped out, there should be a full explanation and justification within the submitted documentation.	activities is included in the ES.	
Cumulative Impacts & In Combination Impacts	A full consideration of the implications of the whole scheme should be included in the ES. All supporting infrastructure should be included within the assessment. The ES should include an impact assessment to identify, describe and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment, (subject to available information): • existing completed projects; • approved but uncompleted projects; • ongoing activities; • plans or projects for which an application has been made and which are under consideration by the consenting authorities; and • plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects.	A cumulative and in-combination assessment has been undertaken in the ES which includes consideration of the types of projects that are advised to be included in such assessments.	Section 19

Table A-2 Consultation log for NRW Scoping Opinion

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
General Comments	Marine and coastal guidance produced by NRW that may provide useful information to help with your project is available here: https://naturalresources.wales/guidance-and-advice/businesssectors/marine/?lang=en	The latest available NRW guidance has been taken account of in the ES as appropriate.	Sections 5 to 19
	The ES submitted should demonstrate consideration of the points raised in this scoping opinion. It is recommended that a table is provided in the ES summarising the scoping opinion comments and how they are addressed in the ES.	This table provides a log of how the scoping opinion comments have been taken into account.	Table A-2
	The EIA must be undertaken by a competent person and the ES must include a competent expert statement.	The EIA has been undertaken by competent consultants that are specialists in their technical field.	Section 4.3
	Where possible, other environmental assessments should be coordinated with the EIA process. However, it is important to note that the Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD) assessment , and any other assessment, are separate processes to the EIA.	It is understood that the HRA and WFD assessment are separate processes to the EIA.	Appendix C, Appendix D
	Throughout the ES robust evidence should be presented so that the potential environmental impacts can be properly understood and evaluated; and appropriate measures identified to avoid, reduce or where necessary compensate for those impacts.	The evidence base and EIA method that has been applied is clearly detailed in the ES.	Sections 4 to 20
	The ES must include: • A Non-Technical Summary (NTS); • A chart or map identifying where the activity will be carried out; • A description of the likely significant effects of the project, whether direct, indirect, secondary, cumulative, transboundary, short-term, medium-term, long-term, permanent, temporary, positive and negative;	These elements have been considered and included in the ES as relevant.	NTS, Sections 3 to 20

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	• A description of the methods used to make the assessment of the significant effects and difficulties encountered in compiling the information and uncertainties involved; • A description of measures to avoid, prevent, reduce or offset identified significant adverse effects and proposed monitoring arrangements; & • A description of the expected significant adverse effects of the project on the environment resulting from the vulnerability of the project to risks of major accidents or disasters.		
	The ES must consider any transboundary impacts where	The potential relevance of transboundary impacts is considered in the ES.	Section 4
	Early engagement with relevant stakeholders is encouraged. We provide advice specific to marine developments on our website Natural Resources Wales / Marine www.naturalresourceswales.gov.uk www.cyfoethnaturiolcymru.gov.uk Page 5 of 11 development. However, you are able to obtain further advice from NRW TE through the NRW Discretionary Advice Service, please see here: https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/advice-for-developers/our-service-to-developers/	The consultation that has been undertaken is detailed in each assessment chapter and this appendix.	Sections 5 to 19, Appendix A
	The UK left the EU on 31 January 2020 – all legal obligations relating to compliance with environmental licences/permits and legislation will continue to apply. NRW on behalf of Welsh Ministers will continue to issue licenses in line with our current practice.	A review of all relevant legislation and policy is included in the ES.	Appendix B
	You must ensure that reference is made to and consideration of compliance with the UK Marine Policy Statement and the now published Welsh National Marine Plan (WNMP) and its associated policies within the submitted ES, alongside any further regional planning documentation. The published Welsh National Marine Plan can be found here: Welsh National Marine Plan: document | GOV.WALES. Implementation guidance for the Welsh National Marine Plan can also be found here: https://gov.wales/welsh-national-marine-plan-implementation-guidance.	The UK Marine Policy Statement and Welsh National Marine Plan has been considered in the ES.	Appendix B, Appendix E

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	We are aware that a separate scoping request has been made to the Marine Management Organisation (MMO). We have not been able to coordinate the response to this request with the MMO; therefore, this Scoping Opinion constitutes the views of NRW PS the MMO will issue a separate scoping opinion.	Noted. The comments that were provided in the MMO's Scoping Opinion are included in the ES.	Table A.1 in Appendix A
	We generally agree with the topics that the report has scoped into the EIA. We have provided specific comment below. Where no comment has been provided the assessment should be carried out as detailed within the scoping report.	Noted.	NA
Legislative and Consenting Framework	Please ensure that all relevant legislation is identified in this chapter of the ES. As it stands, some policies are identified only in specific chapters. For example the Wellbeing of Future Generations (Wales) Act 2015 is missing and this Act has a wider remit than Human Health only.	A review of all relevant legislation and policy is included in the ES.	Appendix B
	NRW PS is required to take its decision in accordance with the appropriate marine policy documents unless relevant considerations indicate otherwise. The WNMP sets out the Welsh Government's policies for the Welsh marine area in connection with its sustainable development. A WNMP Signposting document has been provided with this opinion, the document can be used to set out how the project has considered each policy of the WNMP.	The WNMP signposting document has been populated and is included in the ES.	Appendix E
	In making its decision, NRW PS is required to take all reasonable steps to meet its published well-being objectives, which are designed to maximise NRW's contribution to achieving each of the well-being goals set out in the Well-being of Future Generations (Wales) Act 2015. NRW PS must have enough information in the ES to ensure it acts in accordance with these principles of sustainable development.	The Well-being of Future Generations (Wales) Act 2015 is reviewed in the ES. Implications of the goals are taken account of in the ES as relevant.	Appendix B
	NRW PS requests you to ensure that the ES uses the most up to date classification for the Severn Water Body. NRW TE wish to draw attention to errors made in the Scoping Report with regards to WFD classifications as an EA report from 2009 is www.naturalresourceswales.gov.uk www.cyfoethnaturiolcymru.gov.uk Page 6 of 11 referenced. Recent WFD information for the Severn Lower water body can be	A WFD assessment using the latest available information is included in the ES.	Appendix D

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	obtained from Water Watch Wales, showing the Severn Lower water body is at Moderate status for Ecology and Chemical.		
Geographical boundaries and approach to EIA	We welcome the inclusion of a map with all relevant boundaries. To aid consultees on their assessments, please ensure that all maps presented in the ES include the England/Wales border.	The England/Wales border has been included on all the ES figures.	ES Figures
	As indicated in Section 0.7 the ES should consider the potential impacts to other European States and include a section assessing the transboundary likely significant effects on all elements of the proposal.	The potential relevance of transboundary impacts is considered in the ES.	Section 4
Key Issues to be considered	No responses were received related to topics scoped out of the EIA. NRW PS therefore agrees with the list of factors screened out of the EIA as detailed in Table 6 of the Scoping Report.	Noted.	NA
Physical environment	NRW TE is generally in agreement with the proposal and welcomes the inclusion of Figure 2 as it provides a quantitative representation of resources thickness for the proposed dredging sites. NRW PS requests the use of a colour scale which allows for adequate map interpretation, currently boundaries between some of the levels blend together.	Noted and amended.	Section 5
	NRW PS requests that impacts to wave energy propagation are addressed as part of a physical processes chapter in the final ES, NRW TE indicates that currently these impacts are covered as part of flood defence (Section 5.8 of the Scoping Report).	Effects on coastlines due to changes in wave conditions are assessed in the ES.	Section 5.4
	NRW TE welcome the inclusion of changes to sediment transport in Section 5.2.3 of the Scoping Report; however, they advise to also assess the impacts of potential sediment plumes within the Physical Processes chapter of the ES. NRW PS understands that the ES should include extent and magnitude of potential sediment plumes relating to the proposed zone of influence.	Impacts of sediment plumes are assessed in the water and sediment quality chapter of the ES.	Section 6.3
Water and Sediment quality	NRW PS requests clear sign-posting to water quality issues falling under the navigation impact assessment. NRW TE advises that if this is done, as indicated in the report (page 25), then the Scoping Report is adequate: "Please note that impacts	Water quality issues falling under the navigation impacts are	Sections 6, 13

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	related to vessel movement and risks of water quality impacts from spillages, etc. will be considered as part of the navigation impact assessment."	clearly signposted in the ES.	
Nature conservation – Benthic Ecology	NRW TE considers that the information presented in the report in relation to benthic ecology is adequately describing the proposal, the matters to be addressed in the ES, and identification of cumulative impacts.	Noted.	NA
	NRW PS expect impact on designated features to be adequately assessed within the ES. NRW TE advise that they will expect the proposal to be taken through Appropriate Assessment as part of the shadow HRA for impacts to Annex I habitats. NRW TE understands that, based on the information presented, there is potential for the proposal to have a significant impact on the habitats of the Severn Estuary SAC. NRW TE expects that this Appropriate Assessment will include all relevant information from previous monitoring reports as outlined in the Scoping Report. Furthermore, the D&S IFCA is concerned about the lack of consideration given to the Annex I habitats in the report (particularly H1110 - Sandbanks which are slightly covered by sea water all the time). The objectives for feature H1110 include the maintenance of the variety and distribution of sediment types across the feature, and the maintenance of the gross morphology of the feature (including its depth and profile). It is the D&S IFCA understanding that by the nature of the aggregate extraction process, these objectives will be directly impacted. NRW PS will expect you to give full consideration of this aspects in this chapter of the ES and the shadow HRA.	Full consideration of these objectives for the subtidal sandbanks SAC feature has been given in the ES and HRA.	Sections 5.4, 8.3, Appendix C
	NRW PS requires that hopper water exchanges are considered within the Biosecurity Risk Assessment. NRW TE indicate hopper water exchanged may be advised depending on the location where the hopper dredger is transiting from/to at the start and end of each campaign.	Potential impacts through the introduction and spread of INNS have been assessed in the ES. It should be noted that hopper washing is not proposed.	Section 8.3.6
	NRW PS would like you to consider and provide clarification to NRW TE's comments in relation to Section 4.2.3, Table 3. NRW TE considers that the interaction between a	The impact assessment methodology has been	Section 4.4

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	Probability of Occurrence of 'Medium' and a Magnitude of Change of 'Medium' should result in a 'Medium' Exposure to Change. We would encourage you to discuss this with NRW TE prior to submission of the ES.	updated to take account of this advice.	
	NRW TE does not consider that the following species are established in the Severn Estuary: *Crepidula fornicata*, *Magallana gigas*, and *Hemigrapsus sanguineus* (Section 5.4.2, page 27). NRW TE also indicates that the Chinese mitten crab (*Eriocheir sinensis*) has also been recorded in the Severn Estuary. NRW TE considers that the transfer of hopper water as a result of dredging activities is a viable Invasive Non-Native Species (INNS) pathway. Therefore, NRW PS requests for this to be considered as part of the Biosecurity Risk Assessment and advise you to submit a draft Biosecurity Risk Assessment with your application to avoid determination delays.	A detailed baseline description of non-native species is included in the ES. Potential impacts through the introduction and spread of INNS have been assessed in the ES. It should be noted that hopper washing is not proposed.	Sections 8.2, 8.3.6
	NRW PS advise the continuation of the Regional Seabed Monitoring Plan (RSMP) to assess any future impacts on benthic ecology as part of this proposal.	The RSMP will be continued a best practice.	Section 3.5, 20.2
Nature conservation – Fish and Shellfish	NRW PS agrees with the applicant that the fish community of the Severn Estuary is notably rich. NRW PS has considers responses from D&S IFCA and NRW TE and understands that a detailed assessment of fish receptors will be www.naturalresourceswales.gov.uk www.cyfoethnaturiolcymru.gov.uk Page 8 of 11 required in the ES. Therefore, assessments of habitat suitability for herring spawning as well as sandeel habitat will be required for both areas. Moreover, NRW PS understands that the HRA should consider the effect of the dredging on diadromous fish features and sub-features of the Severn Estuary SAC and Ramsar site, River Usk SAC and River Wye SAC.	An industry wide approach has been adopted specifically for the assessment of herring and sandeel. The HRA has considered the potential effects on all relevant SAC fish features and sub-features.	Sections 9.3.4, 9.3.5, Appendix C
	NRW TE have advised that the proposed activities have a potential to cause a likely significant effect (either alone or in combination with any other plans or projects) on	Noted and taken account of in the HRA.	Appendix C

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	the fish features of the Severn Estuary European sites and should be considered accordingly.		
	NRW TE indicates that the ES and associated HRA should assess the effect of the dredging on sandeel habitats (from seabed removal) and on sandeel individuals (from entrainment in the draghead). NRW TE would advise that you review the supplementary Report to Inform the Appropriate Assessment (RIAA) conducted for Area 531 publicly available through the MMO Public Register under case numbers MLA/2019/00448 or MLA/2019/00457, and NRW TE advice on this supplementary RIAA (attached to this opinion).	The ES and HRA that was undertaken for Area 531 are an important source of information that has been used to support the ES and HRA for Bedwyn Sands and NMG.	Section 9, Appendix C
	It is the D&S IFCA view that the data referred in relation to the marine fish assemblage and its use of the proposed/current sites (EA TRaC data) is limited and cannot adequately characterise the assemblage in the dredging area or fish use of the area. This has been particularly stressed for herring spawning areas, mainly since genetic studies (report available from D&S IFCA) highlights the possible existence of discreet populations of herring in the Severn Estuary.	An industry wide approach has been adopted specifically for the assessment of herring given the possible existence of herring in the estuary.	Section 9.3.5
	D&S IFCA requests that juvenile cod (known locally as codling) are also assessed in the ES as these are abundant in the estuary in the winter months and are thought to belong to a Bristol Channel/Eastern Celtic Sea stock (Ellis *et al*., 2011). This information is not captured in the Ellis *et al*. (2012) report, probably because the underlying sampling does not take place in winter months when cod are abundant in the Severn Estuary.	The potential impacts on juvenile cod (codling) have been assessed.	Section 9.3
	D&S IFCA recommends for updated fish surveys to be conducted to inform the ES. NRW PS recommend the applicant engages with the D&S IFCA and NRW TE to understand the data needs to suitably assess the impacts of the activity on the fish receptors of the area.	The assessment has been based on a range of available data sources, the limitations of which are taken account of in the assessment, in terms of	Section 9

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
		levels of uncertainty and overall confidence.	
Nature conservation – Marine mammals and turtles	NRW TE are generally satisfied with the approach taken to the assessment of marine mammals. Specifically, NRW TE welcomes the addition of harbour porpoise, grey seal, bottlenose dolphin and common dolphin for assessment as they do occur in this licence area, along with the close proximity to the Bristol Channel SAC for which Harbour porpoise is a feature.	Noted.	NA
	NRW PS understands, as advised by NRW TE, that a potential effect on marine mammals prey species in the Severn Estuary would need to be considered.	The implications of the proposed activities on prey resources is considered in the marine mammal impact assessment.	Section 11.3
	NRW TE would like to reiterate the point raised previously for benthic ecology (see Section 7.1.4) in relation to the Impact Assessment Matrices (page 16). As stated above, NRW PS would like you to consider NRW TE's comment and provide further clarification on the highlighted interaction between a Medium Probability of occurrence and a Medium Magnitude of change, resulting in a Low Exposure to change. This issue relating to assessment methodology should be resolved prior to submission of the ES.	The impact assessment methodology has been updated to take account of this advice.	Section 4.4
	NRW TE would like to inform you that an updated version of the Welsh Marine Mammal Atlas is in the process of publication. NRW PS understands the ES should be informed with the best available data. Therefore, the most up to date density maps from this Atlas should be used as these are composed of 30 years of sightings data. Copies of the required maps can be requested in an official sensitive, and not for circulation form from NRW TE.	The most up to date information available at the time of writing has been used to support the ES. Details of the data sources used are included in the ES.	Section 11.1.1
	NRW PS would like to remind you that NRW TE's current position on assessing impacts on marine mammals to the Welsh Marine Mammal Management Units (MMMU) level. This is outlined in NRW's position on the use of MMMU for screening and assessment in HRAs for SACs with marine mammal features (NRW,	MMMUs has informed the screening and assessment stages of the HRA. A range of data	Section 11.1, Appendix C

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	2022 attached). Please see further details in NRW TE response attached to this opinion.	sources have been used to support the marine mammal impact assessment.	
Commercial and recreational fisheries	No comments have been received in relation to Commercial and recreational fisheries; however, please consider the relevant comments raised within the Nature Conservation chapter.	Noted.	NA
Commercial and recreational navigation	No specific issues were raised in relation to Commercial and recreational navigation. The MCA indicates it is satisfied with the work proposed in the report, specifically the consideration of the impact of the proposal on shipping, the safety of navigation, and other marine users.	Noted.	NA
	The MCA welcomes the inclusion of key information on navigation within the study area, including vessel traffic analysis, and the consultation to be carried out with the relevant local Statutory Harbour Authorities.	Further information on the key data sources and consultation undertaken to support the navigation assessment is included in the ES.	Section 13.1
	NRW PS is satisfied that the identification of navigational impact pathways will be carried out including the potential risks associated with encountering Unexploded Ordnance (UXO).	Noted.	NA
	MCA would like to ensure that the applicant is aware of the Guide to Good Practice for ensuring Navigation Safety during Dredging Operations that has been formalised between the British Marine Aggregate Producers Association (BMAPA), MCA and Trinity House (attached to this Scoping Opinion).	Noted and acknowledged.	Section 13
Marine Archaeology	Cadw and the RCAHMW indicate that they agree with the assessment as proposed. The Scoping Report has been informed by a proposed marine archaeology assessment prepared by Wessex Archaeology which highlights that the works will have the potential to directly impact on prehistoric archaeology, maritime and aviation archaeology and an impact on the seascape. It also indicates that there will be no impact on the settings of the designated historic assets. NRW PS consider	Noted.	NA

Topic	Comment	Action (Inc. Clarification Sought /Received, if Applicable)	Sections(s) in ES
	that an assessment of Marine Archaeology should take place as proposed within the scoping report.		
Coast protection and flood defence	No specific comments were received on Coastal protection and flood defence. However, please refer also to the Physical processes section of this Scoping Opinion	Noted.	NA
Air quality, infrastructure and other marine users, and Human Health	No specific comments were received on Air quality, Infrastructure and other marine users, and Human Health. The ES should include an assessment of the impacts as set out in the scoping report.	Noted.	NA
Cumulative Impacts and in-combination effects	The ES must include an assessment of cumulative and in-combination effects, ideally in its own chapter of the ES.	Cumulative and in-combination effects have been assessed in their own ES chapter.	Section 19
	The following data sources may provide useful information on other projects for the assessment of cumulative effects: • The Nationally Significant Infrastructure Projects register: https://infrastructure.planninginspectorate.gov.uk/projects/register-of-applications/ • The Developments of National Significance Register: https://www.gov.wales/developments-national-significance-dns-applications • Planning Policy e.g. Local Development Plans, Transport Plans (National and Local) and National Policy Statements. • An up to date list of marine licensable developments can be found at the following link: http://lle.gov.wales/catalogue/item/MarineLicences	A cumulative and in-combination assessment has been undertaken in the ES which includes consideration of these data sources.	Section 19
	Please ensure this considers all details on the nature conservation receptor specific comments.	Consideration of nature conservation receptors is given in the cumulative and in-combination ES chapter	Section 19

Table A-3 Consultation with other stakeholders

Topic	Contact/Organisation	Comment
Navigation	Royal Yachting Association (RYA)	June 2023: 12/06/2023 Standard email sent by ABPmer, with summary information regarding the proposals. Reply received 19/06/2023. The RYA notes the application for renewal of the Breedon Group Marine Licences to continue to dredge aggregates from Bedwyn Sands and NMG (Severn Estuary) and has no further comment to make.
Navigation	Gloucester Harbour Trustees	June 2023: 12/06/2023 Standard email sent by ABPmer, with summary information regarding the proposals. Reply received 12/06/2023: Based the fact that the organisation is familiar with Breedon's existing operation and that no changes are proposed for the renewal of their licence, they had no comments in terms of navigational safety.
Navigation	ABP South Wales	June 2023: 12/06/2023 Standard email sent by ABPmer, with summary information regarding the proposals. Reply received 04/08/2023: ABP considered that the existing use of these areas has no navigational impact on the ABP ports of South Wales but may be more relevant to Bristol and Sharpness. ABP concluded that they had no comments of relevance in respect to the continuation of the licences.
Navigation	Bristol Port Authority	June 2023: 12/06/2023 Standard email sent by ABPmer, with summary information regarding the proposals. August 2023: 04/08/2023 Standard email re-sent. Reply received 07/08/2023. Email acknowledged by Bristol Port and passed to the conservancy team for comment. Reply received 18/09/2023: No issues or concerns raised. NMG (Areas 455 and 459) is outside the Bristol Port Authority's Statutory Harbour Area (SHA) – they are in the Gloucester Harbour Trustees' SHA. It is only the southern half of the Bedwyn area that impinges the Bristol Port Authority's SHA but the boundary for that area is well outside the navigation channel and turning areas. They noted that they are currently unaware of any future developments which may impact these areas.

Topic	Contact/Organisation	Comment
Fisheries	Welsh Government Marine and Fisheries Division (WGMFD)	July 2023: 11/07/23 Standard email sent by ABPmer, with summary information regarding the proposals. Reply received 17/07/23. WGMFD offered to undertake data analysis of commercial fisheries in ICES rectangles 31E7 and 32E7. Reply received 29/08/23. WGMFD provided details and heat map of all Welsh fishing vessel locations in ICES rectangle 32E7 during 2022-2023 (29.08.23 inclusive).
Fisheries	Welsh Fishermen's Association (WFA)	July 2023: 11/07/23 Standard email sent by ABPmer, with summary information regarding the proposals. No response received.
Fisheries	Devon and Severn Inshore Fisheries and Conservation Authority (DSIFCA)	July 2023: 11/07/23 Standard email sent by ABPmer, with summary information regarding the proposals. No response received.
Fisheries	Charter fishing vessels (x4) – based in Portishead, Cardiff or Penarth	July 2023: 11/07/23 Standard email sent by ABPmer, with summary information regarding the proposals. Three replies received on 11/07/23 and 12/07/23. Two charter vessels stated that the dredging does not detrimentally affect their fishing activities. One charter vessel commented that there have been changes to their fishing grounds within the vicinity of the dredge sites; however, they are unable to attribute such changes to dredging activities.
Fisheries	North Devon Fishermen's Association (NDFA)	Aug 2023: 14/08/23 Standard email sent by ABPmer, with summary information regarding the proposals. Replies received on 14/08/23 and 17/08/23. Stated that a couple of NDFA fishing vessels do fish in the wider study area, however, they should be of no concern to dredging activities. One vessel owner commented that although they do not fish in the area, they are concerned that dredging is damaging the habitat and fish stocks.

A.3 References

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B Regulatory and Planning Framework

B.1 Introduction

This appendix outlines the regulatory and planning framework which the licence applications for Bedwyn Sands and North Middle Ground (NMG) are required to adhere to. Relevant consents, approvals and legislation are summarised in Section B.2. Sections B.3 and B.4 outline planning policy and strategic guidance, and regional and local plans and strategies respectively. Section B.5 outlines the key legislation and planning guidance with respect to marine archaeology.

B.2 Consents, Approvals and Legislation

Obtaining the proposed licences for Bedwyn Sands and NMG will require a range of consents and approvals under different legislative acts, supported by detailed technical and environmental investigations to inform an Environmental Impact Assessment (EIA), a Water Framework Directive (WFD) Assessment and Appropriate Assessment (AA), if required. The principal consents are summarised in the following paragraphs although there is in addition a wide range of related environmental legislation with which the proposal will need to comply. These have also been specifically identified, as appropriate, in the relevant sections of the main Environmental Statement (ES).

The UK is no longer a member of the European Union. EU legislation, as it applied to the UK on 31 December 2020, is now a part of UK domestic legislation, under the control of the UK's Parliaments and Assemblies, and is published on legislation.gov.uk .

Some types of EU legislation such as Regulations and Decisions, are directly applicable as law in an EU Member State. This means that, as a Member State, these types of legislation applied automatically in the UK, under Section 2(1) of the European Communities Act 1972 (c.68), without any further action required by the UK. These types of legislation are published by the Publications Office of the European Union on the EUR-Lex website. This legislation is now published on legislation.gov.uk as 'legislation originating from the EU'.

Other types of EU legislation, such as Directives, are indirectly applicable, which means they require a Member State to make domestic implementing legislation before becoming law in that State. In the UK this was often achieved by making Statutory Instruments rather than passing primary legislation. This implementing legislation has always been published on legislation.gov.uk .

EU legislation which applied directly or indirectly to the UK before 11.00 p.m. on 31 December 2020 has been retained in UK law as a form of domestic legislation known as 'retained EU legislation'. This is set out in Sections 2 and 3 of the European Union (Withdrawal) Act 2018 (c. 16). Section 4 of the 2018 Act ensures that any remaining EU rights and obligations, including directly effective rights within EU treaties, continue to be recognised and available in domestic law after exit.

B.2.1 Seabed ownership and marine licence permission

The seabed encompassing NMG is owned by The Crown Estate (TCE) who own the mineral rights of the seabed out to 12 nautical miles throughout the majority of UK territorial waters. The resource also spans the harbour limits of the Gloucester Harbour Trustees (GHT). Thus, in order to continue dredging aggregates from NMG a marine licence granted by Natural Resource Wales (NRW) under the Marine and Coastal Access Act 2009 (MCAA) is required, as is permission from GHT under the Gloucester Harbour Revision Order 1994 (Part IV, Article 20).

Bedwyn Sands is owned by the Swangrove Estate and permission to dredge has been previously granted by the Mineral Planning Authority, Monmouthshire County Council.

B.2.2 Marine licence permission

The marine licencing system under the Marine and Coastal Access Act 2009 (MCAA) came into force on 6 April 2011 (see Section B.2.12). A new marine licence will be required before aggregate dredging can commence. Given the cross-border nature of Bedwyn Sands and NMG, two licence applications will be submitted, one to the Welsh authority Natural Resources Wales (NRW) and one to the English authority the Marine Management Organisation (MMO). In considering the applications, NRW and the MMO will act in accordance with Government policy statements and guidance, and with the principles of sustainable development, namely:

- Achieving a sustainable marine economy;
- Ensuring a strong, healthy and just society;
- Living within environmental limits;
- Promoting good governance; and
- Using sound science responsibly.

B.2.3 Environmental impact assessment

The amended Environmental Impact Assessment (EIA) Directive (2014/52/EU) required plans, programmes or projects likely to have significant effects on the environment to undergo an environmental assessment, prior to their approval or authorisation. As noted in Section B.2, EU legislation which applied directly or indirectly to the UK before 11.00 p.m. on 31 December 2020 has been retained in UK law as a form of domestic legislation known as 'retained EU legislation'.

The implementing legislation which transposed the EIA Directive into UK law is a series of EIA regulations. The EIA regulations which apply to the proposed marine works elements of the marine aggregate dredging works at Bedwyn Sands and NMG are the Marine Works (EIA) Regulations 2007 (as amended). This EIA has included the identification and consideration of all potential impacts on human beings, fauna and flora, soil, water, air and climate, as well as material assets and the cultural heritage. It has also assessed the interaction between the above elements and, in addition, identified any measures that are required to prevent, reduce or offset any significant adverse effects which may be caused by the marine aggregate dredging.

B.2.4 Appropriate assessment for habitats regulations appraisal

Where a development project, such as the Renewal of Licences for Bedwyn Sands and NMG, is located close to an area designated or proposed under the Birds and Habitats Directives (European Sites) and/or the Ramsar Convention, the requirements of the Conservation of Habitats and Species Regulations 2017 (SI 2017/1012) (the "Habitats Regulations") apply.

In essence, this requires the lead Competent Authority, in this case NRW and the MMO for Welsh and English waters respectively, to determine whether the proposed works are likely to have a significant effect on a European Site and, if so, to undertake an Appropriate Assessment (AA) of the implications of the proposals in light of the site's conservation objectives. The AA takes account of the in-combination effects of the proposal on the protected areas in association with other relevant projects and plans. Where it cannot be ascertained that a project will not have an adverse effect on site integrity, the project can only proceed if it can be demonstrated that there are no more suitable (less damaging) alternatives and that there are Imperative Reasons of Overriding Public Interest (IROPI) sufficient to justify the project. In certain circumstances, the Secretary of State may be required to ensure that adequate compensation has been provided to protect the overall coherence of the Natura 2000 network.

An AA signposting document is provided in Appendix C.

B.2.5 Protected species

B.2.6 Wildlife and Countryside Act

Various species of marine animals are protected from being killed, injured or disturbed under provisions in the Habitats Directive and Section 9(4) and Schedule 5 of the Wildlife and Countryside Act 1981 (WACA) (as amended). Of particular relevance to Bedwyn Sands and NMG are seabirds (including gulls and terns), dolphins, porpoises and pinnipeds (see Sections 10 and 11 of the main ES).

Section 9(4) of the WACA makes it an offence to intentionally or recklessly disturb dolphins, whales or basking sharks subject to a defence that the act was the incidental result of a lawful operation and could not reasonably have been avoided. Natural England and Countryside Council for Wales (now NRW) have produced detailed guidance on the application of these provisions (Natural England and CCW, 2007).

B.2.7 Habitats Regulations

The EU Habitats Directive is transposed into UK Law by the Habitats Regulations. Section 43 of the Regulations make it an offence (subject to exceptions) to deliberately capture, kill, disturb, or trade in the animals listed in Schedule 2 of the Regulations (i.e. European Protected Species). Paragraph 2 of Section 43 specifies that disturbance of animals includes in particular any disturbance which is likely:

- To impair their ability:
  - To survive, to breed or reproduce, or to rear or nurture their young; or
  - In the case of animals of a hibernating or migratory species, to hibernate or migrate; or
- To affect significantly the local distribution or abundance of the species to which they belong.

If protected species are likely to be deliberately disturbed by development operations, the activity can be licenced by NRW or the MMO under the overriding public interest purpose of the Regulations if the necessary criteria are met (Natural England and CCW, 2007). If the degree of deliberate disturbance is considered to fall below the threshold for the Regulations, no licence under this legislation is necessary, but the disturbance may still be an offence under the WACA. In this case, no licence can be issued, as there is no appropriate purpose, and the developer must consider whether the 'incidental result' defence is applicable.

Given the level of protection of these species, potential disturbance impacts to protected species under the Habitats Regulations and WACA have been assessed in this EIA in accordance with Natural England and Countryside Council for Wales/NRW guidance (Natural England and CCW, 2007). The assessment is presented in Sections 7 to 11 of the main ES, which includes necessary measures that will be undertaken to avoid or mitigate any significant impacts.

B.2.8 Invasive species

The European Union Regulation (No 1143/2014) on the prevention and management of the introduction and spread of invasive alien species (IAS) entered into force in 2015. A key instrument of the Regulation is the List of IAS of Union concern, known as 'the Union list'. Species that are included in this list are subject to a number of measures including prevention, early detection and rapid eradication of new invasions, and management of invasions that are already widespread.

The principal UK legislation dealing with non-native species is Section 14 of the WACA. Section 14 makes it illegal to release or allow to escape into the wild any animal which is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state, or is listed in Schedule 9 to the WACA. Schedule 9 contains both animals and plants of which Section 14 applies.

Section 23 of the Infrastructure Act 2015, amended the Section 14 and Schedule 9 of the WACA, by introducing Schedule 9A. Schedule 9A allows both the English and Welsh governments to introduce Species Control Agreements and Orders, which enable rapid responses to eradicate any Schedule 9 species. Guidance on how to implement agreements and orders has been produced by the English and Welsh Government (Defra, 2017 and Welsh Government, 2017, respectively).

B.2.9 Water Framework Directive

The Water Framework Directive (WFD) (2000/60/EEC) establishes a framework for the management and protection of Europe's water resources. It is implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017 (the Water Framework Regulations). The overall objective of the WFD is to achieve "good ecological and good chemical status" in all inland and coastal waters by 2015 (now working towards revised objectives for 2021) unless alternative objectives are set or there are grounds for time limited derogations. For examples, where pressures preclude the achievement of good status (e.g. navigation, coastal defence) in heavily modified water bodies (HMWB), the Directive provides that a lesser objective of "good ecological potential" is set. There is also a general "no deterioration" provision to prevent deterioration in status.

Compliance with chemical status objectives of the WFD is assessed in relation to environmental quality standards (EQSs) for a specified list of 'priority' and 'priority hazardous' substances. These substances were first established by the Priority Substances Directive (PSD) (2008/105/EC) which entered into force in 2009. The PSD set objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions. As required by the WFD and PSD, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated PSD (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting biota EQSs for some existing and newly identified priority substances. The PSD is transposed into UK legislation through the WFD (Standards and Classification) Directions (England and Wales) 2015, which entered into force in September 2015.

Compliance with chemical status objectives of the WFD is assessed in relation to environmental quality standards (EQSs) for a specified list of 'priority' and 'priority hazardous' substances. These substances were first established by the Priority Substances Directive (PSD) (2008/105/EC) which entered into force in 2009. The PSD set objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions. As required by the WFD and PSD, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated PSD (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting

biota EQSs for some existing and newly identified priority substances. The PSD is transposed into UK legislation through the WFD (Standards and Classification) Directions (England and Wales) 2015, which entered into force in September 2015.

Bedwyn Sands and NMG lies within the Severn Lower transitional water bodies. The ES assesses the potential impact dredging activity may have on this water body and the subsequent potential effect on the objectives of the WFD (see Appendix D).

B.2.10 Bathing Waters Directive

The Bathing Waters Directive (76/160/EEC) set out water quality standards to protect the environment at bathing waters throughout the bathing season. The mandatory standards used by the European Commission to determine compliance of bathing waters with the Directive were microbiological parameters - total and faecal coliforms, and three physico-chemical parameters - surface-active substances, mineral oils and phenols. To comply with these standards, bathing waters were expected not to exceed values of 10,000 total coliforms per 100 ml and 2000 faecal coliforms per 100 ml in 95% of samples. The Bathing Water Directive also set more stringent guideline microbiological standards that Member States must endeavour to observe - no exceedance of 500 total coliforms per 100 ml and 100 faecal coliforms per 100 ml in 80% of water quality samples and 100 faecal streptococci per 100 ml in 90% of samples taken.

In 2006, the revised Bathing Water Directive (2006/7/EC) replaced the original Directive, with the first monitoring results reported against the revised Directive in 2015. The overall objective of the revised Directive remained the protection of public health whilst bathing, but it also offers an opportunity to improve management practices at bathing waters and to standardise the information provided to bathers across Europe. It aimed to set more stringent water quality standards and also puts a stronger emphasis on beach management and public information.

The Bathing Water Directive was repealed at the end of 2014, and monitoring of bathing water quality has been reported against revised Bathing Water Directive indicators since 2015. The new classification system considers all samples obtained during the previous four years and, therefore, data has been collected for revised Bathing Water Directive indicators since 2012.

The UK Government's target under the revised Bathing Water Directive is to achieve 'sufficient' for all bathing waters, as described under the Bathing Water Regulations 2013[15] (as amended) which transposed the revised Bathing Water Directive into UK law.

Although there is no need to obtain permission for the proposals under the Bathing Waters Directive, the ES has determined the implications of dredging activity in Bedwyn Sands and NMG on nearby bathing waters (see Section 6 of the main ES).

B.2.11 UK Marine Strategy

The aim of the EU Marine Strategy Framework Directive (MSFD) (adopted in June 2008) is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status (GES) of marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. It enshrines in a legislative framework the ecosystem approach to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use.

15 Replaced by The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019 on 31 January 2020.

The UK Marine Strategy Regulations 2010 implement the MSFD in the UK; these require the UK to take the necessary measures to achieve or maintain Good Environmental Status (GES) by 2020 through the development of a UK Marine Strategy.

In 2012, the UK produced 'Part One of the Marine Strategy', containing information on the first three elements of the MSFD. In 2014, 'Part Two', which focuses on a co-ordinated monitoring programme for the ongoing assessment of GES, was published. 'Part Three' outlines a programme of measures that will contribute to the achievement and maintenance of GES and was published in 2015.

An updated assessment was published in 2019, to summarise progress towards achieving GES, and to set out how the four governments of the UK intend to move towards good environmental status of UK seas over the next six years. With regard to progress, the document (Defra, 2019) notes that:

- The GES for eutrophication, hydrographical conditions, contaminants and contaminants in seafood has largely been achieved;
- There is a mixed picture for marine habitats;
- More needed to understand and protect bird populations;
- Measures to tackle non-indigenous species (NIS) and marine litter need longer to take effect;
- Uncertainty remains about whether GES has been achieved for underwater noise; and
- There is a better understanding of the main pressures preventing the achievement of GES.

B.2.12 Marine and Coastal Access Act 2009

The Marine and Coastal Access Act 2009 (MCAA) aims to ensure clean, healthy, safe, productive and biologically diverse oceans and seas, by putting in place better systems for delivering sustainable development of marine and coastal environments. The Act created a type of Marine Protected Area (MPA) called a Marine Conservation Zone (MCZ) which can be designated anywhere in English and Welsh inshore and UK offshore waters to protect nationally important marine wildlife, habitats, geology and geomorphology.

The first MCZ in English waters was Lundy Island which was designated in 2012 while Skomer was the first Welsh site, designated in 2012. Three tranches of MCZs have now been through consultation and subsequently designated, resulting in 91 designated MCZs currently existing in waters around England. The wider study area falls within the Finding Sanctuary and the MCZ Project Wales regional areas. There are no MCZs that overlap with the Renewal Areas. The closest to the Renewal Areas is Bideford to Foreland Point MCZ located off the north coast of Devon, >50 km from the Renewal Areas (see Section 7.2 of the main ES).

The UK Government has used its powers under the MCAA to designate three candidate pilot highly protected marine areas (HPMAs) in English waters in July 2023. The three sites are Allonby Bay off Cumbria's coast, North East of Farnes Deep in the northern North Sea and Dolphin Head in the English Channel. This initial pilot phase of HPMAs will inform the future of HPMA policy.

In addition to marine nature conservation, other areas of relevance with regards to the MCAA include marine planning, marine licencing and fisheries management. The UK Marine Policy Statement published in March 2011 provides a framework for preparing Marine Plans in order to create a more integrated approach to marine management and ensure that marine resources are used in a sustainable way. A Marine Plan conformance assessment is provided in Appendix E.

The new marine licencing regime was introduced on 6 April 2011, which includes all forms of dredging including marine mineral extraction (see previous Section B.2.2). Sea Fisheries Committees (SFCs) were also replaced by Inshore Fisheries and Conservation Authorities (IFCAs) in April 2011 to conserve marine ecosystems and help achieve a sustainable and profitable fisheries sector.

Due to the cross-border nature of the Severn Estuary, responsibilities for fisheries management are shared between organisations. In England, the northern boundary of the Devon and Severn IFCA District covers the Bristol Channel and Severn Estuary up to the border between England and Wales. Inshore fisheries management in Wales is primarily the responsibility of the Welsh Government which has an inshore fisheries team with responsibilities including monitoring, control and surveillance of sea fishing activities (Welsh Government, 2016a). In addition, the MMO operates a satellite-based vessel monitoring system (VMS) that supports the relevant authorities in monitoring, control and surveillance operations.

B.2.13 Biodiversity Strategies and Plans

UK Biodiversity Action Plan (BAP) priority species and habitats were those that were identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). The original lists of UK BAP priority species and habitats were created between 1995 and 1999, and were subsequently updated in 2007.

Due to devolution and the creation of country-level biodiversity strategies, much of the work previously carried out under the UK BAP is now focused at a country level. Additionally, international priorities have changed, notably in response to the Convention on Biological Diversity's (CBD's) Strategic Plan for Biodiversity 2011-2020 (and its five strategic goals), as well as the 20 'Aichi Targets', agreed at the CBD meeting in Nagoya, Japan, in October 2010. This led to the launch of the EU Biodiversity Strategy (EUBS) in May 2011. As a result, the ‘UK Post-2010 Biodiversity Framework’ was published in July 2012; this succeeded the UK BAP. This framework was agreed by the four governments of the UK. The individual biodiversity strategies of the four governments of the UK, along with the UK Post-2010 Biodiversity Framework, combine to form the UK's National Biodiversity Strategy and Action Plan (NBSAP).

The UK Biodiversity Framework is expected to soon be refreshed to align with the Kunming-Montreal Global Biodiversity Framework, which was adopted at the December 2022 meeting of the Conference of Parties to the CBD.

In addition to the UK ‘Post-2010 Biodiversity Framework’, all four governments of the UK jointly published the UK Marine Strategy Part One in 2012. As noted in Section B.2.11, this provides a series of targets, and associated indicators, for how the UK will achieve good environmental status for UK marine waters. In doing so, it complements the documents that comprise the UK’s NBSAP and provides a framework for the implementation of the CBD within the UK’s marine environment.

In 2011, Defra published ‘Biodiversity 2020: A strategy for England’s wildlife and ecosystem services’. It set the strategy for how England would achieve its commitments under the Aichi Targets and therefore represents England’s national biodiversity strategy. Key aspirations with regard to marine include plans to establish ‘a well-managed, ecologically coherent network of Marine Protected Areas (MPAs)’, which are to cover ‘in excess of 25% of English waters’. The development of marine plans and having fisheries management which supports achievement of Good Environmental Status are also noted as part of the vision for the marine environment.

In 2018, the UK Government published ‘A Green Future: Our 25 Year Plan to Protect the Environment’ (UK Government, 2018). This plan sets out the UK Government’s long-term approach to protecting and enhancing the environment. The plan primarily relates to England. However, as the UK Government retains responsibility for a number of cross-UK environmental matters, parts of the plan have relevance across the UK. The plan does not supersede the documents which combine to create the UK’s NBSAP.

Rather, it sets the wider strategic policy context within which policy areas the UK Government has responsibility for will be further developed.

The 25 Year Plan does not supersede Biodiversity 2020. Rather, it sets a wider strategic policy context within which Biodiversity 2020 will continue to be implemented and a post-2020 strategy for biodiversity conservation will be developed. It also outlines a limited number of specific biodiversity conservation actions to happen by 2020 which compliment Biodiversity 2020.

It is worth noting that, in practice, the UK BAP priority species and habitats continue to be referred to (particularly in local/regional strategies), and have been used to develop statutory lists of priority species and habitats, as required under Section 42 of the Natural Environment and Rural Communities (NERC) Act 2006 and Section 7 of the Environment (Wales) Act 2016 (see next sub-sections below, including a list of English and Welsh species and habitats of 'principal importance' in the coastal and marine zones).

The Wales Biodiversity Partnership (WBP) aims to provide leadership and an expert steer on priorities for each action on biodiversity and ecosystems in Wales which is administered through the Wales Biodiversity Strategy Board (WBSB) and the WBP working groups.

Various habitats and species requiring BAPs have been identified by the relevant local authorities and incorporated into major Local BAPs (LBAPs) within the wider study area, including Bristol, Newport, Monmouthshire, Cardiff, North Somerset and South Gloucestershire (amongst others). The purpose of a Local BAP is 'to focus resources to conserve and enhance biodiversity by means of local partnerships, taking account of both national and local priorities'. These plans include actions to address the needs of the UK priority habitats and species in the local area, together with a range of other plans for habitats and species that are of local importance or interest. The plans are designed to involve local people and organisations through the practical delivery of biodiversity conservation and aim to promote public awareness and contribute to international conservation efforts.

B.2.14 Natural Environment and Rural Communities (NERC) Act 2006

The Natural Environment and Rural Communities (NERC) Act came into force in October 2006. In addition to establishing Natural England as the body responsible for conserving, enhancing, and managing England's natural environment, the Act also made amendments to the both the Wildlife and Countryside Act 1981 and the Countryside and Rights of Way (CROW) Act 2000. For example, it extended the CROW biodiversity duty to public bodies and statutory undertakers and altering enforcement powers in connection with wildlife prosecution. In addition to this, the NERC Act contains a number of additional measures designed to help streamline delivery and simplify the legislative framework, such as changes to the remit and constitution of the Joint Nature Conservation Committee (JNCC), reconstitution of the Inland Waterways Amenity Advisory Council, and improving the governance arrangements for the National Parks.

Section 41 (S41) of the Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The list has been drawn up in consultation with Natural England, as required by the Act.

The S41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under Section 40 of the Natural Environment and Rural Communities Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions.

There are 943 species of principal importance and 56 habitats of principal importance included on the S41 list; those located in the coastal and marine zone are listed in Table B-1 and Table B-2 below.

Table B-1 Marine and coastal species listed as being of principal importance in England

Species	
Birds	
Anser albifrons subsp. albifrons	European Greater White-fronted Goose
Branta bernicla subsp. bernicla	Dark-bellied Brent Goose
Cygnus columbianus subsp. bewickii	Bewick's Swan (Tundra Swan)
Larus argentatus subsp. argenteus	Herring Gull
Limosa limosa subsp. limosa	Black-tailed Godwit
Numenius arquata	Curlew
Puffinus mauretanicus	Balearic Shearwater
Sterna dougallii	Roseate Tern
Fish	
Alosa alosa	Allis Shad
Alosa fallax	Twaite Shad
Ammodytes marinus	Lesser Sandeel
Anguilla anguilla	European Eel
Aphanopus carbo	Black Scabbardfish
Centrophorus granulosus	Gulper Shark
Centrophorus squamosus	Leafscraper Shark
Centroscymnus coelolepsis	Portuguese Dogfish
Cetorhinus maximus	Basking Shark
Clupea harengus	Herring
Coryphaenoides rupestris	Roundnose Grenadier
Dalatias licha	Kitefin Shark
Dipturus batis	Common Skate
Gadus morhua	Cod
Galeorhinus galeus	Tope Shark
Hippocampus guttulatus	Long-snouted Seahorse
Hippocampus hippocampus	Short-snouted Seahorse
Hippoglossus hippoglossus	Atlantic Halibut
Hoplostethus atlanticus	Orange Roughy
Isurus oxyrinchus	Shortfin Mako
Lamna nasus	Porbeagle Shark
Lampetra fluviatilis	River Lamprey
Lophius piscatorius	Sea Monkfish
Merlangius merlangus	Whiting
Merluccius merluccius	European Hake
Micromesistius poutassou	Blue Whiting
Molva dypterygia	Blue Ling
Molva molva	Ling
Osmerus eperlanus	Smelt (Sparling)
Petromyzon marinus	Sea Lamprey
Pleuronectes platessa	Plaice
Prionace glauca	Blue Shark
Raja undulata	Undulate Ray
Reinhardtius hippoglossoides	Greenland Halibut
Rostroraja alba	White or Bottlenosed Skate
Salmo salar	Atlantic Salmon
Salmo trutta	Brown/Sea Trout

Species	
Salvelinus alpinus	Arctic Charr
Scomber scombrus	Mackerel
Solea solea	Common Sole
Squalus acanthias	Spiny Dogfish
Thunnus thynnus	Blue-fin Tuna
Trachurus trachurus	Horse Mackerel
Invertebrates	
Amphianthus dohrnii	Sea-fan Anemone
Anisodactylus poeciloides	Saltmarsh Short-spur
Atrina fragilis	Fan Mussel
Colletes halophilus	Sea-aster Colletes Bee
Edwardsia ivelli	Ivell's Sea Anemone
Edwardsia timida	Timid Burrowing Anemone
Eunicella verrucosa	Pink Sea-fan
Funiculina quadrangularis	Tall Sea Pen
Gammarus insensibilis	Lagoon Sand Shrimp
Haliclystus auricula	Kaleidoscope Jellyfish
Heleobia stagnorum	Lagoon Spire Snail
Leptopsammia pruvoti	Sunset Cup Coral
Lucernariopsis campanulata	A Stalked Jellyfish
Lucernariopsis cruxmelitensis	St John’s Jellyfish
Mitella pollicipes	Gooseneck Barnacle
Nematostella vectensis	Starlet Sea Anemone
Ostrea edulis	Native Oyster
Pachycordyle navis	Brackish Hydroid
Palinurus elephas	Crayfish, Crawfish or Spiny Lobster
Tenellia adspersa	Lagoon Sea Slug
Triops cancriformis	Tadpole Shrimp
Victorella pavida	Trembling Sea-mat
Mammals and turtles	
Balaenoptera acutorostrata	Minke Whale
Balaenoptera borealis	Sei Whale
Balaenoptera physalus	Fin Whale
Caretta	Loggerhead Turtle
Delphinus delphis	Common Dolphin
Dermochelys coriacea	Leatherback Turtle
Eubalaena glacialis	Northern Right Whale
Globicephala melas	Long-finned Pilot Whale
Grampus griseus	Risso's Dolphin
Lagenorhynchus acutus	Atlantic White-sided Dolphin
Lagenorhynchus albirostris	White-beaked Dolphin
Mesoplodon bidens	Sowerby’s Beaked Whale
Mesoplodon mirus	True’s Beaked Whale
Orcinus orca	Killer Whale
Phoca vitulina	Common Seal (Eastern Atlantic Harbour Seal)
Phocoena	Harbour Porpoise
Physeter catodon	Sperm Whale
Tursiops truncatus	Bottlenosed Dolphin
Ziphius cavirostris	Cuvier's Beaked Whale

Species	
Plants	
Anotrichium barbatum	Bearded Red Seaweed
Atriplex pedunculata	Pedunculate Sea-purslane
Carex maritima	Curved Sedge
Corrigiola litoralis	Strapwort
Cruoria cruoriaeformis	A Red Seaweed
Dermocorynus montagnei	A Red Seaweed
Hordeum marinum	Sea Barley
Lithothamnion corallioides	Coral Maërl
Matthiola sinuata	Sea Stock
Padina pavonica	Peacock's Tail
Phymatolithon calcareum	Common Maërl
Puccinellia fasciculata	Borrer's Saltmarsh-grass
Spartina maritima	Small Cord-grass

Table B-2 Marine and coastal habitats listed as being of principal importance in England

Category	Habitat Name
Wetland	Coastal and floodplain grazing marsh
Coastal	Coastal saltmarsh
	Coastal sand dunes
	Coastal vegetated shingle
	Intertidal mudflats
	Maritime cliff and slopes
	Saline lagoons
Marine	Blue mussel beds
	Estuarine rocky habitats
	Fragile sponge and anthozoan communities on subtidal rocky habitats
	Horse mussel beds
	Intertidal boulder communities
	Intertidal chalk
	Maërl beds
	Mud habitats in deep water
	Peat and clay exposures
	Sabellaria alveolata reefs
	Sabellaria spinulosa reefs
	Seagrass beds
	Sheltered muddy gravels
	Subtidal chalk
	Subtidal sands and gravels
	Tide-swept channels

B.2.15 Environment (Wales) Act 2016

The Environment (Wales) Act 2016 provides the legislative framework for the sustainable management of natural resources. Central to this is building resilience into natural systems and communities, in order to tackle the challenges faced now and into the future. The Act includes a provision for NRW to report on the current state of natural resources, ecosystems and the benefits they provide through the publication of a State of Natural Resources Report (SoNaRR). The SoNaRR highlights the condition and extent of Wales' natural resources, their ability to respond to pressures including climate change, and their ability to provide benefits for society (CCC, 2016).

The Act also requires Welsh Ministers to prepare a National Natural Resource Policy (NNRP) which will draw on the evidence from SoNaRR to set out the priorities for the sustainable management of natural resources at a national level. It will outline how the sustainable management of Wales' natural resources will provide benefits to society and the economy as well as the environment, supporting the goals outlined in the Wellbeing of Future Generations (Wales) Act (CCC, 2016).

Section 7 of the Act (Biodiversity lists and duty to take steps to maintain and enhance biodiversity) replaces the duty in Section 42 of the NERC Act 2006. It noted that priority lists for species and habitats would duly be published. Marine and coastal species and habitats have been extracted from the lists available on the Wales Biodiversity Partnership Website, and are listed in Table B-3 and Table B-4.

Table B-3 Marine and coastal species listed as being of principal importance in Wales

Species	
Cnidaria	
Eunicella verrucosa	Pink sea-fan
Haliclystus auricula	A stalked jellyfish
Lucernariopsis campanulata	A stalked jellyfish
Coastal and marine Birds	
Anser albifrons subsp. flavirostris	Greenland greater Whitefronted Goose
Branta bernicula subsp. bernicula	Dark-bellied Brent Goose
Charadrius hiaticula	Ringed Plover
Cygnus columbianus subsp.	Bewick's Swan
Larus argentatus subsp. argenteus	Herring Gull
Larus ridibundus	Black-headed Gull
Limosa lapponica	Bar-tailed Godwit
Numenius arquata	Eurasian Curlew
Pluvialis apricaria	Golden Plover
Puffinus mauretanicus	Balearic Shearwater
Sterna dougallii	Roseate Tern
Fish	
Alosa alosa	Allis shad
Alosa fallax	Twaite shad
Ammodytes marinus	Sand-eel
Anguilla anguilla	European eel
Clupea harengus	Herring
Dipturus batis	Common skate
Gadus morhua	Cod
Galeorhinus galeus	Tope shark
Hippocampus guttulatus	Long snouted seahorse
Lamna nasus	Porbeagle shark
Lophius piscatorius	Sea monkfish
Merlangius merlangus	Whiting
Merluccius merluccius	European hake
Molva molva	Ling
Osmerus eperlanus	Smelt (Sparling)

Species	
Palinurus elephas	Crayfish, crawfish or spiny lobster
Petromyzon marinus	Sea lamprey
Pleuronectes platessa	Plaice
Prionace glauca	Blue shark
Raja brachyura	Blonde ray
Raja clavata	Thornback ray
Raja undulata	Undulate ray
Rostroraja alba	White or Bottlenosed skate
Salmo salar	Atlantic salmon
Salmo trutta	Brown / Sea trout
Salvelinus alpinus	Arctic char
Scomber scombrus	Mackerel
Solea solea	Sole
Squalus acanthias	Spiny dogfish
Squatina squatina	Angel shark
Trachurus trachurus	Horse mackerel
Invertebrates	
Alkmaria romijni	Tentacled lagoon worm
Arctica islandica	Icelandic cyprine or Oceanquahog
Atrina fragilis	Fan mussel
Edwardsia timida	Burrowing anemone
Ostrea edulis	Native oyster
Tenellia adspersa	Lagoon sea slug
Mammals and turtles	
Balaenoptera acutorostrata	Minke whale
Balaenoptera physalus	Fin whale
Caretta caretta	Loggerhead turtle
Cetorhinus maximus	Basking shark
Delphinus delphis	Common dolphin
Dermochelys coriacea	Leatherback turtle
Globicephala melas	Long-finned pilot whale
Grampus griseus	Risso's dolphin
Hyperodon ampullatus	Northern bottlenose whale
Lagenorhynchus acutus	Atlantic white-sided dolphin
Lagenorhynchus albirostris	White-beaked dolphin
Megaptera novaeangliae	Humpback whale
Orcinus orca	Killer whale
Phocoena phocoena	Harbour porpoise
Stenella coeruleoalba	Striped dolphin
Tursiops truncatus	Bottlenose dolphin
Ziphius cavirostris	Cuvier`s beaked whale
Plants	
Anotrichium barbatum	Bearded red seaweed
Cruoria cruoriaeformis	A red seaweed
Dermocorynus montagnei	A red seaweed
Lithothamnion corallinoides	Coral maerl
Padina pavonica	Peacock's tail
Phymatolithon calcareum	Common maerl

Table B-4 Marine and coastal habitats listed as being of principal importance in Wales

Category	Habitat Name
Littoral Rock	Intertidal boulder communities
	Sabellaria alveolata reefs
	Estuarine rocky habitats
Littoral sediment	Intertidal boulder communities
	Intertidal mudflats
	Seagrass beds
	Sheltered muddy gravels
	Peat and clay exposures
Sublittoral rock	Coastal saltmarsh
	Fragile sponge & anthozoan communities on subtidal rocky habitats
	Carbonate reefs
Sublittoral sediment	Tidal swept channels
	Subtidal mixed muddy sediments
	Mud habitats in deep water
	Musculus discors beds
	Blue mussel beds
	Horse mussel beds
	Maerl beds
	Saline lagoons
	Subtidal sands and gravels
Supralittoral rock	Maritime cliff and slopes
Supralittoral sediment	Coastal sand dunes
	Coastal vegetated shingle
Improved grassland	Coastal and floodplain grazing marsh

B.2.16 The Well-being of Future Generations (Wales) Act 2015

The Well-being of Future Generations (Wales) Act 2015 aims uphold and promote sustainable development and well-being by ensuring that public bodies think more about the long term, work more effectively with people, communities and each other, prevent problems and take a more collaborative approach (Welsh Government, 2016b). A number of public bodies (including NRW) are legally bound to the Act; to make sure these bodies are all working towards the same vision, the Act puts in place seven well-being goals:

- A prosperous Wales;
- A resilient Wales;
- A more equal Wales;
- A healthier Wales;
- A Wales of cohesive communities;
- A Wales of vibrant culture and thriving Welsh language; and
- A globally responsible Wales.

Public bodies listed in the Act must maximise their contribution to achieving each of the well-being goals by setting objectives and subsequently taking all reasonable steps (in exercising its functions) to meet those objectives. The objectives set by the body depend on its role and regional coverage.

NRW states that their responsibilities involve protecting and improving people's health and well-being as well as assuring the natural resources of Wales are sustainably maintained, enhanced and used, now and in the future (NRW, 2023). NRW therefore contribute to the Acts objectives by promoting the provision and improvement of opportunities for access to the countryside and open spaces, improving resilience to flooding and protecting the environment from emissions to air, land and water (NRW, 2015).

B.3 Planning Policy and Strategic Guidance

As part of the application for dredging at Bedwyn Sands and NMG, all relevant national, regional and local planning policy and guidance has been taken fully into account. A review of the key aspects of this policy and guidance, in so far as it relates Bedwyn Sands and NMG, is provided in this section.

The summary provided below comprises a review of the most relevant marine and planning policy documents to Bedwyn Sands and NMG which should be viewed as current as at the date of the submission of this ES.

B.3.1 UK Marine Policy Statement

The UK Marine Policy Statement (HM Government, 2011) contributes to the achievement of sustainable development in the UK marine area comprising the Bedwyn Sands and NMG. It provides the framework for preparing Marine Plans and taking decisions affecting the marine environment, ensuring that marine resources are used in a sustainable way in line with the high level marine objectives and thereby:

- Promote sustainable economic development;
- Enable the UK's move towards a low-carbon economy, in order to mitigate the causes of climate change and ocean acidification and adapt to their effects;
- Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage assets; and
- Contribute to the societal benefits of the marine area, including the sustainable use of marine resources to address local social and economic issues.

The Statement recognises the importance of the UK marine aggregate resource stating that:

> *"the extraction of marine dredged sand and gravel should continue to the extent that this remains consistent with the principles of sustainable development, recognising that marine aggregates are a finite resource and in line with the relevant guidance and legislation"*.

The Marine Policy Statement considers marine aggregates to present reduced impacts on local communities compared to the extraction of land-won aggregates, in particular with regard to the extraction process and transportation (HM Government, 2011). Wider social and economic benefits include skilled, stable employment and the generation of income through the construction industry supply chain. The MPS states that a marine licence or other regulatory approval to dredge should only be issued if the decision maker is content that the proposed dredging is environmentally acceptable. Potential adverse impacts are listed to include changes to the hydrodynamic regime that may alter coastal processes; loss of seabed habitat and heritage assets; impacts on fisheries and secondary impacts to marine life and habitat associated with sediment plumes; disturbance of fish spawning, migration routes, nursery and overwintering areas; overspills from dredging vessels and impacts on geodiversity.

B.3.2 Planning Policy Wales

The 11th edition of the Planning Policy Wales (PPW) was published in February 2021. It sets out the land use planning polices of the Welsh Government and is supplemented by a series of Technical Advice

Notes (TANs) and Minerals Technical Advice Notes (MTAN). The PPW document aims to translate the Welsh Governments commitment to sustainable development into the planning systems so that it can play an appropriate role in moving towards sustainability. Local planning authorities must prepare a local development plan (LDP). This LDP will be the statutory development plan for the area and will supersede the existing development plan.

The following sections of the PPW are of relevance to the Bedwyn Sands and NMG application: 5 – Productive and Enterprising Places, and 6 – Distinctive and Natural Places.

It should be noted here that planning law only applies within the territory of local authorities which, as a general rule, extends only to the low water mark.

B.3.3 National Planning Policy Framework - England

The National Planning Policy Framework (NPPF) was first published in March 2012, and last revised in September 2023. The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It does not contain specific policies for nationally significant infrastructure projects or waste projects, as particular considerations apply for such projects. Planning authorities must take the NPPF into account in the preparation of local and neighbourhood plans. At the heart of the NPPF is a presumption in favour of sustainable development, which 'should be seen as a golden thread running through both plan-making and decision-taking'.

The following five sections of the current NPPF are of particular relevance to the Bedwyn Sands and NMG Proposal: 6 - Building a strong, competitive economy; 14 - Meeting the challenge of climate change, flooding and coastal change; 15 - Conserving and enhancing the natural environment; 16 - Conserving and enhancing the historic environment; and 17 - Facilitating the sustainable use of minerals.

Paragraph 170 of the NPPF provides the following specific policies that are relevant to the planning and licensing of marine aggregate operations:

> *'In coastal areas, planning policies and decisions should take account of the UK Marine Policy Statement and marine plans. Integrated Coastal Zone Management should be pursued across local authority and land/sea boundaries, to ensure effective alignment of the terrestrial and marine planning regimes.'*

Further, the updated NPPF contains a section on 'Facilitating the sustainable use of minerals'. The introductory paragraph to this section (Paragraph 209) reads as follows:

> *'It is essential that there is a sufficient supply of minerals to provide the infrastructure, buildings, energy and goods that the country needs. Since minerals are a finite natural resource, and can only be worked where they are found, best use needs to be made of them to secure their long-term conservation.'*

Paragraph 210 includes a provision for policies to '

> *'safeguard existing, planned and potential sites for: the bulk transport, handling and processing of minerals; the manufacture of concrete and concrete products; and the handling, processing and distribution of substitute, recycled and secondary aggregate material.'*

Paragraph 213 of the NPPF requires that planning authorities should plan for a steady and adequate supply of aggregates by:

'Preparing an annual Local Aggregate Assessment, either individually or jointly, to forecast future demand, based on a rolling average of 10 years' sales data and other relevant local information, and an assessment of all supply options (including marine dredged, secondary and recycled sources).'

It should again be noted here that planning law only applies within the territory of local authorities which, as a general rule, extends only to the low water mark.

B.3.4 Marine Plan(s)

Welsh National Marine Plan

The Welsh part of the Severn Estuary is covered by the WNMP published in November 2019 by the Welsh Government (Welsh Government, 2019). Policies are presented within an economic, social and environmental framework, helping to support the high-level objectives set out in the UK Marine Policy Statement (MPS), as well as sustainable development of the marine area.

The plan covers both the Welsh inshore region (from mean high water spring tides out to 12 nautical miles) and offshore region (beyond 12 nautical miles). Unless otherwise stated, policies in this plan apply to both regions. The plan area is adjacent to two English marine planning regions, the North West and South West marine plan areas. The plan also shares boundaries with Northern Ireland, the Isle of Man and Republic of Ireland (Welsh Government, 2019).

The management of activities in Welsh water is split between devolved functions, the responsibility of Welsh Ministers, and functions retained by the UK Government. The plan includes provision relating to the devolved and retained functions and has been adopted with the agreement of the UK Secretary State for Environment, Food and Rural Affairs (Welsh Government, 2019).

The role of Marine Plan is to set out how the MPS will be implemented in specific areas, providing detailed policy and spatial guidance and to help ensure that decisions within an area contribute to the delivery of UK, national and any area specific policy objectives.

The vision of the WNMP is:

"Welsh Seas are clean, healthy, safe, productive and biologically diverse:

- Through an ecosystem approach, natural resources are sustainably managed, and our seas are healthy and resilient, supporting a sustainable and thriving economy;
- Through access to, understanding of and enjoyment of the marine environment and maritime cultural heritage, health and well-being are improving;
- Through Blue Growth more jobs and wealth are being created and are helping coastal communities become more resilient, prosperous and equitable with a vibrant culture; and
- Through the responsible deployment of low carbon technologies, the Welsh marine area is making a strong contribution to energy security and climate change emissions targets. "

In order to deliver the marine plan vision and support sustainable development, 13 objectives have been defined. The following sector objective relates to aggregates:

"Objective 1 - To continue to use marine aggregates resources at a rate and in locations which best meet our current and future needs by ensuring adequate reserves are provided for through long-term licences."

Sector specific policies are split into two categories, supporting and safeguarding policies. The policies related to marine aggregates are listed in Table B-5.

Table B-5 Welsh marine policies related to marine aggregates

Policy	Wording
AGG_01: Aggregates (supporting)	*AGG_01 a: Proposals for new aggregate extraction will be supported, within any tonnage limits, where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.* *AGG_01 b: Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities:* ▪ for the sustainable use of wider marine aggregate natural resources; ▪ to define and, once in place, further develop and refine Strategic Resource Areas for aggregates; in order to support the sustainable development of the aggregate sector through marine planning.
SAF_01: Safeguarding existing activity	*SAF_01 a: Proposals likely to have significant adverse impacts upon an established activity covered by a formal application or authorisation must demonstrate how they will address compatibility issues with that activity.* *Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for the proposal to progress under exceptional circumstances.* *SAF_01 b: Proposals likely to have significant adverse impacts upon an established activity not subject to a formal authorisation must demonstrate how they will address compatibility issues with that activity.* *Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for proceeding. Under SAF 01 a and b, compatibility should be demonstrated through, in order of preference:* ▪ Avoiding significant adverse impacts on those activities, and/or ▪ Minimising significant adverse impacts where these cannot be avoided; and/or ▪ Mitigating significant adverse impacts where they cannot be minimised
SAF_02: Safeguarding strategic resources	*Proposals which may have significant adverse impacts upon the prospects of any sector covered by this plan to engage in sustainable future strategic resource use (of resources identified by an SRA) must demonstrate how they will address compatibility issues with that potential resource use. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for proceeding. Compatibility should be demonstrated through, in order of preference:* ▪ Avoiding significant adverse impacts on this potential strategic resource use, and/or ▪ Minimising significant adverse impacts where these cannot be avoided; and/or ▪ Mitigating significant adverse impacts where they cannot be minimised

These WNMP sector policies set out the Welsh Government's strategic level policy in relation to the extraction of marine sand and gravel for aggregates from Welsh waters. The WNMP recognises that '*marine aggregates play a strategically important role in the national and local supply of aggregates predominantly for use in construction projects*' (paragraph 255).

South West Marine Plan

The English Government has developed a suite of marine plans for eleven separate areas that cover English waters. Each plan will provides a long-term (20 years) view of activities in that area and will be reviewed every three years. The English part of Bedwyn Sands and NMG is within the south west inshore marine plan area which covers an area of approximately 2,000 km of coastline stretching from the Severn Estuary border with Wales to the north round to the River Dart in Devon in the south east, taking in a total of approximately 16,000 km² of sea.

The South West Marine Plan covers the south west inshore and south west offshore marine plan areas. The Plan introduces a strategic approach to planning within the English inshore and offshore waters. It provides a clear, evidence-based approach to inform decision-making by marine users and regulators on where, when or how activities might take place within the south west inshore and south west offshore marine plan areas.

The Plan should enable activities to move more quickly from concept to consent by identifying sectors and, where possible, appropriate spatial areas suitable for investment, encouraging earlier and clearer communication between proponents and regulatory decision-makers, and by early identification of proposals that are inappropriate or unfeasible.

Implementation of the Plan's policies, through more informed decision-making, will help to ensure that the management of different and potentially competing activities contributes to the achievement of sustainable development and optimal use of the marine area's natural capital. Policies encourage enhancement and provide protection for vulnerable habitats and species, maintenance of natural defences against climate change and flooding, and will improve the well-being of coastal communities and support a strong marine economy.

The vision of the South West Marine Plans is:

"As England's Ocean Peninsula, the South West marine plan areas are sustainably developed and thriving, based on their unique nature and close links to the maritime area in terms of economy, society, environment and governance. Across the region, fishing, tourism, port development and harbour regeneration, with the associated safeguarded or new infrastructure, support a strong and diversified maritime economy that encourages sustainable economic growth and employment. Emerging and innovative renewable energy opportunities, which contribute significantly to the UK's commitment to reduce greenhouse gas emissions to net zero by 2050, have been realised in suitable locations throughout the South West marine plan areas.

Community well-being and cohesion, and the recognition, enhancement, protection and appreciation of natural assets, cultural heritage, and seascape and landscape, are being delivered through plan-led management. Sustainable access to the marine area and management along the coast and in estuaries have enhanced resilience to climate change, such as in the protection and use of saltmarsh in the Severn Estuary. The region's close economic and social ties to defence on the south Devon coast continue to be supported.

Authorities and relevant organisations are working together to successfully apply plan-led management. Decisions made in the south west marine plan areas apply an ecosystem approach and natural capital framework. The environment is in a better state than before, and Good Environmental Status is achieved. Biodiversity is conserved, enhanced and restored through applying well-established principles of biodiversity gain and delivery of a well-managed ecologically coherent network of marine protected areas.

Transboundary effects are effectively considered through close liaison across regional, national and international borders."

The extraction of aggregates from Bedwyn Sands and NMG will support this vision, as it will help to continue to support the economic development of the area covered by the South West Marine Plans (and beyond). This, in turn, will provide social benefits, particularly in terms of providing opportunities for employment, and supporting the construction industry, whilst not inhibiting access and coexistence. Further details on the need for and objectives of the proposed aggregate extraction are included in Section 2 of the ES.

Overall, the proposed aggregate extraction is considered to support the South West Marine Plans' Vision.

In order to deliver the marine plan vision and support sustainable development, 13 objectives have been defined (Table B-6). The ongoing extraction at Bedwyn Sands and NMG will support a number of objectives, in particular objectives 2, 4 and 6.

Table B-6 Objectives of the South West Marine Plans

Objectives	
Achieving a sustainable marine economy	
1	Infrastructure is in place to support and promote safe, profitable and efficient marine businesses.
2	The marine environment and its resources are used to maximise sustainable activity, prosperity and opportunities for all, now and in the future.
3	Marine businesses are taking long-term strategic decisions and managing risks effectively. They are competitive and operating efficiently.
4	Marine businesses are acting in a way which respects environmental limits and its socially responsible. This is rewarded in the market place.
Ensuring a strong, healthy and just society	
5	People appreciate the diversity of the marine environment, its seascapes, its natural and cultural heritage and its resources and can act responsibly.
6	The use of the marine environment is benefiting society as a whole, contributing to resilient and cohesive communities that can adapt to coastal erosion and flood risk, as well as contributing to physical and mental wellbeing.
7	The coast, seas, oceans and their resources are safe to use.
8	The marine environment plays an important role in mitigating climate change.
9	There is equitable access for those who want to use and enjoy the coast, seas and their wide range of resources and assets and recognition that for some island and peripheral communities the sea plays a significant role in their community.
10	Use of the marine environment will recognise, and integrate with, defence priorities, including the strengthening of international peace and stability and the defence of the United Kingdom and its interests.
Living within environmental limits	
11	Biodiversity is protected, conserved and, where appropriate, recovered, and loss has been halted.
12	Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.
13	Our oceans support viable populations of representative, rare, vulnerable, and valued species.

B.3.5 National and Regional Guidelines for Aggregates Provision in England 2005-2020

The national and regional guidelines are presented in a technical note which sets out revised aggregate provision in England for the period between 2005 and 2020, replacing those published in 2003 (see Department for Communities and Local Government, 2009). The note also indicates how the guidelines should be taken into account in the planning process, and outlines arrangements for future monitoring and review. The 2005-2020 guidelines assume that the contribution of marine sand and gravel to the overall aggregate industry in the UK will be 16 Mt, and increase of 14% from the 2003 guidelines.

When compared to the previous 2003 guidelines, this document envisages an increase in the assumed contribution of marine sand and gravel from 14 Mt per annum to 16 Mt (a 14% increase).

It is worth noting that (as outlined in Section 2 of the main ES), more than this is already being extracted in the UK. Over the last 10 years, just over 18 Mt has been extracted on average. The Crown Estate has recently estimated that there is potential for demand to increase to 29 Mt per year by 2030 (The Crown Estate, 2021).

B.3.6 Marine Minerals and Good Practice Guidance

Previously, the Marine Minerals Guidance documents provided guidance on the 'extraction by dredging of sand, gravel and other minerals from the English seabed', and the 'control of marine minerals dredging' (ODPM, 2002; MFA, 2008). However, these documents have has since been withdrawn.

As a replacement for the original Marine Minerals Guidance documents, in 2017, BMAPA and The Crown Estate, published a Good Practice Guidance (BMAPA and The Crown Estate, 2017), which was produced in consultation with Defra, the MMO, Natural England, JNCC, Historic England and Cefas. This summarises the procedures and measures which have been developed over the years with regard to planning, licensing, environmental assessment, monitoring, mitigation and management, in order to protect the environment and other seabed interests and to ensure the sustainability of the industry. These procedures were summarised in Section 3.5 of the main ES.

The Guidance outlines that the dredging industry works to such clearly defined licensing, operational, and management frameworks in order to:

- Ensure the long-term sustainable management of the available resources;
- Maximise the extraction of available resources and minimise waste in individual dredging areas;
- Minimise the footprint of the activity on the seabed;
- Minimise the adverse environmental impacts of the aggregate extraction process; and
- Mitigate the effects of aggregate dredging on other users of the seabed.

The Guidance also provides background on the importance of the English aggregates dredging industry with regard to the construction industry, flood and coastal defence measures and major infrastructure projects. The regulatory framework is also outlined, and dredging operations explained. Potential physical, biological, social and economic impacts are furthermore summarised.

B.4 Regional and Local Plans and Strategies

B.4.1 River Basin Management Plans

Under the WFD, River Basin Management Plans have been drawn up for river basin districts across England and Wales with the aim of improving water in rivers, estuaries, coasts and aquifers. The study area falls within the within the South West, Severn and Western Wales River Basin Management Plans (RBMPs), which were updated in 2022 (the WFD requires that the plans are reviewed and updated every six years).

Further information on the WFD and RBMPs is provided in the Water Quality section, Section 6 of the main ES, and Appendix D.

B.4.2 Shoreline Management Plans

Shoreline Management Plans (SMPs) are non-statutory documents intended to both inform and be supported by the statutory planning process. They provide a large-scale assessment of the risks associated with coastal evolution and present a policy framework to address these risks to people and the developed, historic and natural environment in a sustainable manner. It assesses likely changes over the next 100 years, taking account of the condition of existing defences. The intention of an SMP is to develop a broad coast defence strategy that is technically, economically and environmentally sustainable.

The initial Severn Estuary SMP was published in 2001 by the Severn Estuary Coastal Group (SECG) with the second SMP (SMP2) published in 2010 (Atkins, 2009). The SMP2 boundary extends from Lavernock Point to Anchor Head and undertook high level assessments in order to provide a general picture of change, and does not focus on local issues.

B.4.3 Severn Estuary Partnership

The Severn Estuary Partnership (SEP) is an independent estuary-wide project set up by Local Authorities, the Environment Agency and the countryside agencies. It forms a partnership between all organisations and individuals who have declared an interest in a coordinated approach of the management of all activities on the Severn Estuary (including the Inner Bristol Channel).

The Strategy for the Severn Estuary 2017-2027 was published by the SEP in 2017 and streamlined the original version of 2001 (SEP, 2017). The revised and streamlined 2017 Strategy provides a framework to inform more coordinated policy development, practices and strategies for the Severn Estuary. As marine planning develops in both England and Wales, the Strategy document will help ensure a more integrated approach for the Severn Estuary Region, particularly throughout the time of uncertainty in European governance. The Strategy also provides context to inform and support decision-making for a wide range of proposed estuary developments, including those related to maritime uses, minerals and marine renewable energy. It states that:

> *'The estuary provides a multitude of resources for industries around its shores through transport, trade and materials, energy generation and much more. Ports, aggregates, chemical processing companies and power stations, as well as many others, all play a vital role in the economy and social structure of the area.'*

B.5 Marine Archaeology - Key Legislation and Planning Guidance

Please refer to Appendix F, the archaeological desk-based assessment, for related legislation and guidance.

B.6 References

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C Appropriate Assessment Signposting Document

C.1 Introduction

This appendix represents an '*Appropriate Assessment (AA) Signposting Document*' for the licence applications to dredge aggregates from Bedwyn Sands and North Middle Ground (NMG) in the Severn Estuary.

It identifies, under relevant subject headings, those sections and/or paragraphs within the Environmental Statement (ES) and any relevant supporting documentation that contains the information needed by the Competent Authorities, which in this case are the Marine Management Organisation (MMO) and Natural Resources Wales (NRW), to produce an AA under the Conservation of Habitats and Species Regulations 2017 (as amended) (hereafter the 'Habitats Regulations')[16]. It is designed to serve the following functions.

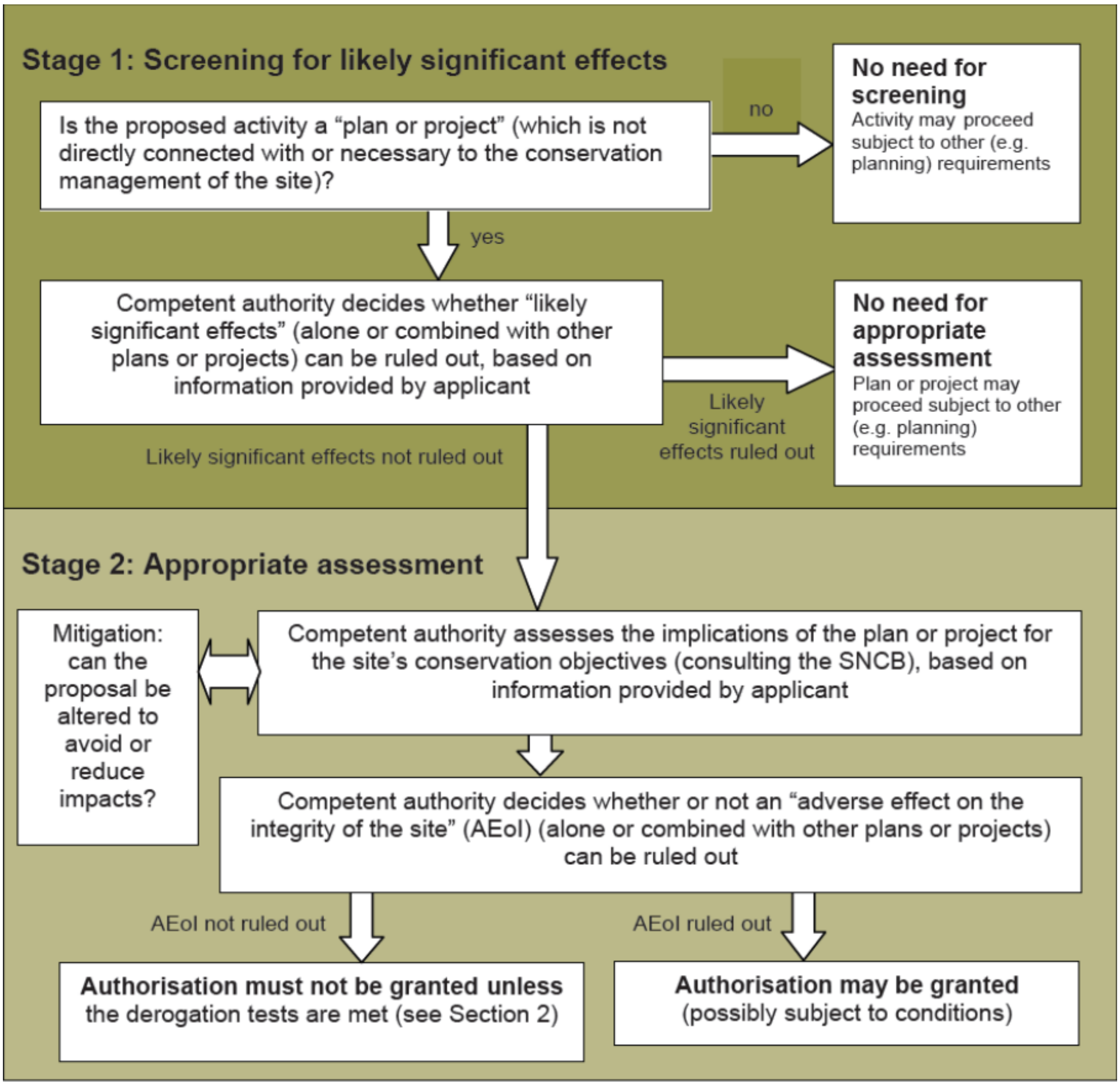
1. **Avoid unnecessary repetition of information**. The information required for an Environmental Impact Assessment (EIA) and for an AA often overlaps and it is now seen as good practice to avoid replication of this information. Therefore, where comprehensive data and descriptions already exist in the main ES, cross-references to these sources of relevant information are made.
2. **Add new information that is specific to the implementation of Regulation 63 of the Habitats Regulations**. In those instances where information is needed by a Competent Authority to produce an AA but is not available in the ES report (and any relevant supporting documentation) then such additional information has been included here.
3. **Act as an auditable checklist of AA information**. This appendix is designed to provide a confirmatory checklist, which ensures that all the relevant information that is needed for an AA is contained in the ES and any supporting documentation. It also ensures that a clear audit trail exists from the Regulation 33, 35 or 37 Advice (depending on date of publication), through the consultation responses to the final assessment about the impacts of a plan or project on the integrity of a European Designated Site.
4. **Assist the Competent Authorities and its consultees**. The overall aim of this appendix is to provide a concise and readable documentation that will make it easier for the Competent Authorities to consult on, and produce, an AA.

It is recognised that the scope and content of an HRA can vary on a case-by-case basis, however the information provided is considered to represent most, if not all, the detail required and is based on recommendations within relevant Habitats Regulations Guidance which apply in England and Wales (Defra, 2012; Welsh Government, 2021; Natural England, 2023). The key stages of the HRA process are shown in Figure C-1.

The Habitats Regulations provide for the protection of European sites including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). In addition, these regulations apply to Ramsar sites (designated under the 1971 Ramsar Convention for their internationally important wetlands), candidate SACs, potential SPAs, and proposed and existing European offshore marine sites. Collectively, these sites are referred to as European/Ramsar sites.

16 Following the UK leaving the EU, these have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (HMSO, 2019).

This appendix seeks to provide the information needed by the Competent Authorities (MMO and NRW) to determine whether the proposal is likely to have an adverse effect on the integrity of any European/Ramsar sites and to undertake an HRA, if required. In compiling this information, the starting point has been Natural England and the Countryside Council for Wales' (now NRW) advice provided in Regulation 33(2) of the Habitats Regulations for the Severn Estuary/Môr Hafren European Marine Site (Natural England and CCW, 2009). The latest conservation objectives for all component designations of these sites have also been consulted, and supplementary advice considered, where available (consulting Natural England's Designated Sites System / Website). Consideration has also been given to prior consultation and correspondence with stakeholders that has been undertaken with respect to the Bedwyn and NMG application.



Source: Defra, 2012

Figure C-1 Summary of the key stages for an HRA

C.2 Need for an Appropriate Assessment

Bedwyn Sands and NMG are located within the boundary of European/Ramsar sites and so has the potential to affect them. Therefore, the MMO and NRW, as the lead Competent Authorities in England and Wales respectively, need to take account of the Habitats Regulations. Because of the location it has been assumed that the scheme will require an AA under Regulations 63(1) of the Habitats Regulations if it is likely to have a significant effect on an SAC or SPA. This Regulation states that:

> *"(1) A competent authority, before deciding to undertake, or give any consent, permission, or other authorisation for a plan or project which:*
>
> *(a) is likely to have significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects); and*
> *(b) is not directly connected with or necessary to the management of the site*
>
> *must make an appropriate assessment of the implications of the plan or project for that site in view of that site's conservation objectives".*

The decision as to whether a HRA is required or not is related to the assessment of 'Likely Significant Effect', or LSE (Figure C-1), which is recognised as being a 'coarse filter' or statement that the anticipated effects of the proposal will be more than trivial, i.e. that the anticipated changes resulting from a proposal have the potential to impact on a receptor designated as a feature of a European/Ramsar Site. It does not automatically follow that an impact will occur, or that the impact would be significant, with a decision of LSE being purely an indication of the need for an AA. The interpretation of the term significant under the Habitats Directive is therefore different to its use under the EIA Directive, with LSE in the Habitats Directive effectively analogous to a Screening Decision under EIA.

C.3 Information on the Need for the Proposed Development

A comprehensive description of the project's rationale and the importance of marine aggregates is presented in Sections 2.1 to 2.2 of the ES.

C.4 Scheme Description and Alternatives

A detailed description of the scheme is provided in Section 3 and a demonstration that no alternatives exist that could have lower environmental impacts is provided in Section 2.3 of the main ES.

C.5 Consultation with Relevant Parties

The MMO and NRW have been consulted as part of the process of preparing the ES and formal Scoping Opinions were received from NRW on 03 February 2023 (NRW ref: SC2204) and from the MMO on 17 April 2023 (Application reference no: EIA/2022/00044). Appendix A of the ES summarises the consultation that has been undertaken as part of this EIA. A 'consultation' sub-section has furthermore been included in the introductory text for each of the individual topic assessment chapters, summarising the key comments raised through consultation, and how/where they have been addressed.

C.6 Designated Sites That Could Be Directly or Indirectly Affected

The international nature conservation importance of the wider study area has been recognised through a number of statutory designations that acknowledge the importance of coastal/marine habitats (see Section 7.2.1 of the ES).

SACs and SPAs are defined as European Sites in the Habitats Regulations. Where the European Site lies below highest astronomical tide i.e. land covered (continuously or intermittently) by tidal waters, or any part of the sea, in or adjacent to Great Britain, up to the seaward limit of territorial waters, it is defined as a European Marine Site (EMS). The following EMS is located within the wider study area (as described in Section 7.2.1 of the main ES):

- Severn Estuary/Môr Hafren EMS, comprising:
  - Severn Estuary/Môr Hafren SAC;
  - Severn Estuary SPA; and
  - Severn Estuary/Môr Hafren Ramsar site.

The sites have been designated for a number of reasons and the conservation objectives in England and Wales (Natural England and CCW, 2009; Natural England, 2016a; 2016b) for each of the international designations comprising the EMS are presented in Table C-1.

The study areas directly overlap with all three of the above European/Ramsar sites. As described in Section 4.1, the study area is defined as the area over which the potential direct and indirect impacts of the activity are predicted to occur. These are called the primary and secondary impact zones (PIZ and SIZ) and are based on a conservative assessment of the likely zones over which impacts might be realised (Section 4.1). However, additional European/Ramsar sites beyond the PIZ and SIZ may be brought into the assessment where a designated feature may have a foraging range beyond the PIZ and SIZ. For example, some seabird species have the potential to forage over very large distances (above 100 km), and as such have the potential to forage in the study area. Given the mobile nature of the Severn Estuary Ramsar and SPA bird features, the whole EMS is considered as being potentially affected by dredging in Bedwyn Sands and NMG.

In addition, diadromous fish features and sub-features of the River Usk and River Wye SACs could be affected by the proposed dredging activities when on migration to and from the rivers. The conservation objectives in England and Wales (Natural England, 2018; NRW 2022a; b) for these fish interest features are presented in Table C-1.

With regard to any other European/Ramsar sites which are located further afield, no additional sites have been considered within this HRA, as the only commonly recorded long-distance foraging seabird species in the Severn Estuary are Gulls and the Great Cormorant. Gulls utilise both terrestrial and marine habitats and do not rely on capturing food solely through diving or surface feeding like many other marine birds. Furthermore, the foraging ranges for these seabirds encompass an extensive area and are not spatially restricted. With respect to marine mammals, Bedwyn Sands and NMG are a very small area in the context of the known foraging ranges of harbour porpoise and grey seal with both species foraging over large areas within the Bristol Channel and wider Irish Sea. Therefore, no LSE on features of designated sites for marine mammals in the wider study area (such as Lundy Island SAC and Bristol Channel Approaches SAC) are anticipated.

A tabulated summary of the features, subfeatures, conservation objectives and predicted impacts with regards to the screened in European/Ramsar sites is included in Table C-2 to Table C-7 of this appendix.

C.7 An Understanding of the Designated Features' Conservation Objectives and Favourable Condition Target

The conservation objectives for each of the screened in European/Ramsar sites are presented in Table C-1. The potential impacts upon these sites are considered on a *feature-by-feature* basis to ensure that there is full clarity in the assessment process.

As the Natural England (2016a; 2016b) Conservation Objectives for the Severn Estuary SAC/SPA have not been agreed with NRW for Wales, the objectives from the 2009 Regulation 33 document (Natural England and CCW, 2009) should also be applied. Given the cross-border nature of the River Wye SAC, there are two sets of Conservation Objectives are also presented for this site: one set for England (Natural England, 2018) and another for Wales (NRW, 2022b)

The Ramsar objectives have been adapted from the European Site Conservation Objectives for the Severn Estuary/Môr Hafren SAC and SPA published by Natural England (Natural England 2016a; 2016b) and the favourable condition tables published in the Regulation 33(2) advice documents (Natural England and CCW, 2009).

C.8 Baseline Description of Relevant Interest Features

Details of the existing condition of relevant interest features and supporting features are addressed in the ES under the following categories: Physical Processes (Section 5), Water and Sediment Quality (Section 6), Nature Conservation (Section 7), Benthic Habitats and Species (Section 8), Fish and Shellfish (Section 9) and Ornithology (Section 10).

C.9 Impacts to Relevant Interest Features

As outlined in Section C.6 of this appendix, the direct and indirect impact zones identified for Bedwyn Sands and NMG directly overlap with Severn Estuary/Môr Hafren SAC. Due to the mobile nature of some of the bird species, the Severn Estuary SPA and Ramsar site may also be affected, as could intertidal habitats at the coast. In addition, mobile migratory fish features and sub-features of the River Usk and River Wye SACs could be affected by the proposed dredging activities. Consequently, there is potential for LSE for these five sites.

The summary Table C-2 to Table C-7 describe the potential effects of dredging activities at Bedwyn Sands and NMG on each of the attributes of the interest features within the five screened-in European/Ramsar sites by cross-referring to the relevant sections of the ES. In each case the significance of the effects are described. Please note that Natural England supplementary conservation advice packages are not currently available for the Severn Estuary SAC and SPA (Natural England, 2023).

The EIA significance judgement is very different to the Habitats Regulations significance (as described above) but is considered to be a valuable guide to assessing the effect on the conservation targets/objectives. The targets are intended to define the desired condition of an attribute, taking into account fluctuations due to natural change. Assessing the predicted effects of the scheme in relation to the targets enables the potential effect on favourable condition and hence on the designated status of these sites to be determined. This in turn informs the conclusion of LSE and the decision of whether or not an adverse effect on integrity of the European/Ramsar site is predicted.

A potential impact pathway as a result of the dredging activity within Bedwyn Sands and NMG will only be an issue to interest features that form part of the marine and coastal environment in the study area. In other words, there is no route of interaction for terrestrial and/or freshwater organisms and habitats. Furthermore, an impact pathway will only exist at locations where a direct and/or indirect impact will occur as a result of the proposed activities.

C.10 Preventative Measures and Mitigation

The summary Table C-2 to Table C-7 include the best practice procedures and standard mitigation measures (summarised in Section 3.5 of the ES).

Under the standardised definitions of impact significance that are applied within the EIA (Section 4.4 of the ES), where effects are identified as either 'insignificant' or 'minor adverse', this is the equivalent of no adverse effect on the given (sub)feature. In these cases then no mitigation measures are considered to be required.

The final assessment of the implications of the predicted impact on the relevant favourable condition target is presented in Table C-2 to Table C-7.

C.11 In-combination Effects with Other Plans or Projects

The other extant projects that are relevant to this project and the in-combination effects with these proposals are considered in Section 19 of the ES. Projects and activities screened in from the assessment (see Section 19.3) are as follows:

- Other aggregate Licence Areas;
- Ongoing commercial and recreational fishing;
- Ongoing ports, navigation and shipping;
- Ongoing recreation and tourism;
- Disposal sites;
- Hinkley Point C construction; Hinkley Point B decommissioning;
- Steart managed realignment scheme;
- Bristol Deep Sea Container Terminal (BDSCT);
- Severn Flood Risk Management Plan (FRMP);
- The Avonmouth Severnside Enterprise Area (ASEA) Ecology Mitigation and Flood Defence Project; and
- Cardiff Coastal Defence Scheme.

The in-combination effects on ecological receptors are assessed in Table 19-5. Given that the proposed activity is already undertaken and well established in the region, and the cumulative/in combination effects are very small in relation to the wider study area, it is concluded that the risk of a significant adverse in-combination effect occurring is unlikely.

C.12 Integrity of the European Marine Site

In an AA, it is necessary to determine whether the project or plan would adversely affect the integrity of the EMS in the light of the site's conservation objectives. The integrity of a site has previously been defined as the coherence of its ecological structure and function, across its whole area that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified (DETR, 1994).

The decision on whether integrity is affected is to be made by the Competent Authorities. However, to assist this decision, Table C-2 to Table C-7 include a column about the potential effects on the relevant conservation objectives and favourable condition targets. Please note that there are two different sets of Conservation Objectives for the River Wye SAC (i.e. one for England and one for Wales). Based on previous NRW advice on other cross-border projects, with regards to the Conservation Objectives for the Severn Estuary EMS, reference must only be made to the agreed cross-border conservation advice package for the Severn Estuary (Natural England and CCW, 2009) as these are the agreed Conservation Objectives for cross boundary sites. The following tables present the assessment:

- Table C-2 for the Severn Estuary/ Môr Hafren SAC;
- Table C-3 for the Severn Estuary/ Môr Hafren SPA;
- Table C-4 for the Severn Estuary/Môr Hafren Ramsar;
- Table C-5 River Usk/ Afon Wysg SAC;
- Table C-6 River Wye/ Afon Gwy SAC – Wales; and
- Table C-7 River Wye SAC – England.

In light of the assessment presented in these tables, all the impacts - whether direct or indirect, permanent or temporary - to interest features are considered to be not significant.

In conclusion, it is considered that dredging within Bedwyn Sands and NMG is not anticipated to affect the integrity of any of the European/Ramsar Sites as no failure of the conservation objectives (alone or in-combination) is predicted.

Table C-1 Conservation objectives for the European/Ramsar sites screened into the assessment

International Designations	Conservation Objective
Severn Estuary/ Môr Hafren SAC	**England (Natural England, 2016a)**: The conservation objective for the sites is to "*Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:* ▪ *The extent and distribution of qualifying natural habitats and habitats of qualifying species* ▪ *The structure and function (including typical species) of qualifying natural habitats* ▪ *The structure and function of the habitats of qualifying species* ▪ *The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely* ▪ *The populations of qualifying species, and,* ▪ *The distribution of qualifying species within the site."* The qualifying features of the SAC are: ▪ H1110. Sandbanks which are slightly covered by sea water all the time; Subtidal sandbanks; ▪ H1130. Estuaries; ▪ H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats; ▪ H1170. Reefs; ▪ H1330. Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*); Atlantic salt meadows; ▪ S1095. *Petromyzon marinus*; Sea lamprey; ▪ S1099. *Lampetra fluviatilis*; River lamprey; and ▪ S1103. *Alosa fallax*; Twaite shad.
	Cross-border (Natural England and CCW, 2009): Subject to natural processes, the conservation objective **for the "estuaries" feature** is to maintain the feature in favourable condition, in particular: i. The total extent of the estuary is maintained; ii. The characteristic physical form (tidal prism/cross sectional area) and flow (tidal regime) of the estuary is maintained; iii. The characteristic range and relative proportions of sediment sizes and sediment budget within the site is maintained; iv. The extent, variety and spatial distribution of estuarine habitat communities within the site is maintained; v. The extent, variety, spatial distribution and community composition of hard substrate habitats and their notable communities is maintained; vi. The abundance of the notable estuarine species assemblages is maintained or increased; vii. The physico-chemical characteristics of the water column support the ecological objectives described above; viii. Toxic contaminants in water column and sediment are below levels which would pose a risk to the ecological objectives described above; and ix. Airborne nutrient and contaminant loads are below levels which would pose a risk to the ecological objectives described above. Subject to natural processes, the conservation objective **for the "subtidal sandbanks" feature** is to maintain the feature in favourable condition, in particular: i. The total extent of the subtidal sandbanks within the site is maintained; ii. The extent and distribution of the individual subtidal sandbank communities within the site is maintained;

International Designations	Conservation Objective
	iii. The community composition of the subtidal sandbank feature within the site is maintained; iv. The variety and distribution of sediment types across the subtidal sandbank feature is maintained; and v. The gross morphology (depth, distribution and profile) of the subtidal sandbank feature within the site is maintained. Subject to natural processes, the conservation objective **for the "mudflats and sandflats" feature** is to maintain the feature in favourable condition, in particular: i. The total extent of the mudflats and sandflats feature is maintained; ii. The variety and extent of individual mudflats and sandflats communities within the site is maintained; iii. The distribution of individual mudflats and sandflats communities within the site is maintained; iv. The community composition of the mudflats and sandflats feature within the site is maintained; and v. The topography of the intertidal flats and the morphology (dynamic processes of sediment movement and channel migration across the flats) are maintained. Subject to natural processes, the conservation objective **for the "Atlantic salt meadow" feature** is to maintain the feature in favourable condition, in particular: i. The total extent of Atlantic salt meadow and associated transitional vegetation communities within the site is maintained; ii. The extent and distribution of the individual Atlantic salt meadow and associated transitional vegetation communities within the site is maintained; iii. The zonation of Atlantic salt meadow vegetation communities and their associated transitions to other estuary habitats is maintained; iv. The relative abundance of the typical species of the Atlantic salt meadow and associated transitional vegetation communities is maintained; v. The abundance of the notable species of the Atlantic salt meadow and associated transitional vegetation communities is maintained; vi. The structural variation of the salt marsh sward (resulting from grazing) is maintained within limits sufficient to satisfy the requirements of conditions iv and v above and the requirements of the Ramsar and SPA features; vii. The characteristic stepped morphology of the salt marshes and associated creeks, pills, drainage ditches and pans, and the estuarine processes that enable their development, is maintained; and viii. Any areas of Spartina anglica salt marsh (SM6) are capable of developing naturally into other saltmarsh communities. Subject to natural processes, the conservation objective **for the "Reefs" feature** is to maintain the feature in favourable condition, in particular: i. The total extent and distribution of Sabellaria reef is maintained; ii. The community composition of the Sabellaria reef is maintained; iii. The full range of different age structures of Sabellaria reef are present; and iv. The physical and ecological processes necessary to support Sabellaria reef are maintained. Subject to natural processes, the conservation objective **for the "River lamprey Lampetra fluviatilis" feature** is to maintain the feature in favourable condition, in particular: i. The migratory passage of both adult and juvenile river lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality; ii. The size of the river lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term; iii. The abundance of prey species forming the river lamprey's food resource within the estuary, is maintained; and iv. Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above. Subject to natural processes, the conservation objective for the "**Sea lamprey Petromyzon marinus" feature** is to maintain the feature in favourable condition, in particular: i. The migratory passage of both adult and juvenile sea lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality; ii. The size of the sea lamprey population in the Severn Estuary and the rivers which drain into it, is at least maintained as is at a level that is sustainable in the long term; iii. The abundance of prey species forming the sea lamprey's food resource within the estuary, is maintained; and iv. Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.

International Designations	Conservation Objective
	Subject to natural processes, the conservation objective **for the "Twaite shad Alosa fallax" feature** is to maintain the feature in favourable condition, in particular: i. The migratory passage of both adult and juvenile twaite shad through the Severn Estuary between the Bristol Channel and their spawning rivers is not obstructed or impeded by physical barriers, changes in flows or poor water quality; ii. The size of the twaite shad population within the Severn Estuary and the rivers draining into it is at least maintained and is at a level that is sustainable in the long term; iii. The abundance of prey species forming the twaite shad's food resource within the estuary, in particular at the salt wedge, is maintained; and iv. Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.
Severn Estuary SPA	**England (Natural England, 2016b):** The conservation objective for the sites is to *"Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;* ▪ *The extent and distribution of the habitats of the qualifying features* ▪ *The structure and function of the habitats of the qualifying features* ▪ *The supporting processes on which the habitats of the qualifying features rely* ▪ *The population of each of the qualifying features, and,* ▪ *The distribution of the qualifying features within the site."* The qualifying features of the SPA are: ▪ A037 *Cygnus columbianus bewickii*; Bewick's swan (Non-breeding) ▪ A048 *Tadorna tadorna*; Common shelduck (Non-breeding) ▪ A051 *Anas strepera*; Gadwall (Non-breeding) ▪ A149 *Calidris alpina alpina*; Dunlin (Non-breeding) ▪ A162 *Tringa totanus*; Common redshank (Non-breeding) ▪ A394 *Anser albifrons albifrons*; Greater white-fronted goose (Non-breeding) ▪ Waterbird assemblage
	Cross-border (Natural England and CCW, 2009): Subject to natural processes, the conservation objective for **the "Bewick's swan population and its supporting habitats"** feature is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the Bewick's swan population is no less than 289 individuals; ii. The extent of saltmarsh at the Dumbles is maintained; iii. The extent of intertidal mudflats and sandflats at Frampton Sands, Waveridge Sands and the Noose is maintained; iv. The extent of vegetation with an effective field size of >6 ha and with unrestricted bird sightlines >500 m at feeding, roosting and refuge sites are maintained; v. Greater than 25% cover of suitable soft leaved herbs and grasses in winter season throughout the transitional saltmarsh at the Dumbles is maintained; and vi. Aggregations of Bewick's swan at feeding, roosting and refuge sites are not subject to significant disturbance. Subject to natural processes, the conservation objective **for the "European white-fronted goose population and its supporting habitats"** feature is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the wintering European white fronted goose population is no less than 3,002 individuals; ii. The extent of saltmarsh at the Dumbles is maintained;

International Designations	Conservation Objective
	iii. The extent of intertidal mudflats and sandflats at Frampton Sands, Waveridge Sands and the Noose is maintained; iv. Greater than 25% cover of suitable soft-leaved herbs and grasses is maintained during the winter on saltmarsh areas; v. Unrestricted bird sightlines of >200 m at feeding and roosting sites are maintained; and vi. Aggregations of European white-fronted goose at feeding or roosting sites are not subject to significant disturbance. Subject to natural processes, the conservation objective **for the "Dunlin population and its supporting habitats**" feature is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the wintering dunlin population is no less than 41,683 individuals; ii. The extent of saltmarsh and associated strandlines is maintained; iii. The extent of intertidal mudflats and sandflats is maintained; iv. The extent of hard substrate habitats is maintained; v. The extent of vegetation with a sward height of <10 cm is maintained throughout the saltmarsh; vi. The abundance and macro-distribution of suitable invertebrates in intertidal mudflats and sandflats is maintained; vii. The abundance and macro-distribution of suitable invertebrates in hard substrate habitats is maintained; viii. Unrestricted bird sightlines of >200 m at feeding and roosting sites are maintained; and ix. Aggregations of dunlin at feeding or roosting sites are not subject to significant disturbance. Subject to natural processes, the conservation objective **for the "Redshank population and its supporting habitats"** feature is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the wintering redshank population is no less than 2,013 individuals; ii. The extent of saltmarsh and associated strandlines is maintained; iii. The extent of intertidal mudflats and sandflats is maintained; iv. The extent of hard substrate habitats is maintained; v. The extent of vegetation with a sward height of <10 cm throughout the saltmarsh is maintained; vi. The abundance and macro-distribution of suitable invertebrates in intertidal mudflats and sandflats is maintained; vii. The abundance and macro-distribution of suitable invertebrates in hard substrate habitats is maintained; viii. Unrestricted bird sightlines of >200 m at feeding and roosting sites are maintained; and ix. Aggregations of redshank at feeding or roosting sites are not subject to significant disturbance. Subject to natural processes, the conservation objective **for the "Shelduck population and its supporting habitats" feature** is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the wintering shelduck population is no less than 2,892 individuals; ii. The extent of saltmarsh is maintained; iii. The extent of intertidal mudflats and sandflats is maintained; iv. The extent of hard substrate habitats is maintained; v. The abundance and macro-distribution of suitable invertebrates in intertidal mudflats and sandflats is maintained; vi. Unrestricted bird sightlines of >200 m at feeding and roosting sites are maintained; and vii. Aggregations of shelduck at feeding or roosting sites are not subject to significant disturbance.

International Designations	Conservation Objective
	Subject to natural processes, the conservation objective **for the "Gadwall population and its supporting habitats"** feature is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the wintering gadwall population is no less than 330; ii. The extent of intertidal mudflats and sandflats is maintained; iii. Unrestricted bird sightlines of >200 m at feeding and roosting sites are maintained; and iv. Aggregations of gadwall at feeding or roosting sites are not subject to significant disturbance. Subject to natural processes, the conservation objective **for the "waterfowl assemblage and its supporting habitats" feature** is to maintain the feature in favourable condition, in particular: i. The 5 year peak mean population size for the waterfowl assemblage is no less than 68,026 individuals; ii. The extent of saltmarsh and their associated strandlines is maintained; iii. The extent of intertidal mudflats and sandflats is maintained; iv. The extent of hard substrate habitats is maintained; v. Extent of vegetation of <10 cm throughout the saltmarsh is maintained; vi. The abundance and macroscale distribution of suitable invertebrates in intertidal mudflats and sandflats is maintained; vii. The abundance and macroscale distribution of suitable invertebrates in hard substrate habitats is maintained; viii. Greater than 25% cover of suitable soft leaved herbs and grasses during the winter on saltmarsh areas is maintained; ix. Unrestricted bird sightlines of >500 m at feeding and roosting sites are maintained; and x. Waterfowl aggregations at feeding or roosting sites are not subject to significant disturbance.
Severn Estuary/ Môr Hafren Ramsar Site	**Natural England and CCW (2009):** Subject to natural processes, the conservation objective for the "assemblage of migratory fish species" feature is to maintain the feature in favourable condition, in particular: i. The migratory passage of both adults and juveniles of the assemblage of migratory fish species through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality; ii. The size of the populations of the assemblage species in the Severn Estuary and the rivers which drain into it, is at least maintained and is at a level that is sustainable in the long term; iii. The abundance of prey species forming the principle food resources for the assemblage species within the estuary, is maintained; and iv. Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.
River Usk/ Afon Wysg SAC	**NRW (2022a):** The migratory fishes designated under the EU Habitats Directive in the Usk (and their corresponding EU code) are sea lamprey *Petromyzon marinus* (1095); River lamprey *Lampetra fluviatilis* (1099); Twaite shad *Alosa fallax* (1103); Allis shad *Alosa alosa* (1102); and Atlantic salmon *Salmo salar* (1106). The vision for these features is for them to be in a favourable conservation status, where all of the following conditions are satisfied: ▪ The Conservation Objective for the watercourse must be met; ▪ The population of the feature in the SAC is stable or increasing over the long term; ▪ The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g. food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future.

International Designations	Conservation Objective
	Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed in view of Conservation Objectives for the watercourse; ▪ There is, and will probably continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a longterm basis.
River Wye/ Afon Gwy SAC	**England (Natural England, 2018):** With regard to the SAC and the natural habitats and/or species for which the site has been designated, and subject to natural change; Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring; ▪ The extent and distribution of qualifying natural habitats and habitats of qualifying species ▪ The structure and function (including typical species) of qualifying natural habitats ▪ The structure and function of the habitats of qualifying species ▪ The supporting processes on which qualifying natural habitats and habitats of qualifying species rely ▪ The populations of qualifying species, and, ▪ The distribution of qualifying species within the site.
	Wales (NRW, 2022b): The migratory fish species designated under the EU Habitats Directive in the Wye (and their corresponding EU code) are: sea lamprey *Petromyzon marinus* (1095); river lamprey *Lampetra fluviatilis* (1099); twaite shad *Alosa fallax* (1103); Allis shad *Alosa alosa* (1102); and Atlantic salmon *Salmo salar* (1106). The vision for these features is for them to be in a favourable conservation status, where all of the following conditions are satisfied: ▪ The conservation objective for the watercourse must be met; ▪ The population of the feature in the SAC is stable or increasing over the long term; ▪ The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g. food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed; There is, and will continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.
Refer to: The Severn Estuary/Môr Hafren SAC and Severn Estuary SPA outlined above with regards to "Estuaries", "Bewick's swan", "European white-fronted goose", "Dunlin", "Redshank", "Shelduck", "Gadwall" and "waterfowl assemblage" features, for all of which the conservation objective is to maintain the feature in favourable condition.	

Table C-2 Favourable condition table for the Severn Estuary/ Môr Hafren SAC

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Sub-feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Estuaries		Extent	No decrease in extent due to man induced changes from the established baseline.	Not applicable as the extent of the estuary will not be affected (see Sections 5.4 and 8.3).-				
	All sub-features	Morphology	The intra- and inter- estuarine tidal prism/cross section relationship should not deviate significantly from an established baseline subject to natural processes.	Overall, it is considered highly unlikely that the continued extraction of aggregate from Bedwyn Sands and NMG Licence Renewal Areas, will result in any LSE on the physical processes of the wider study area. Tidal prism is not predicted to be significantly affected, nor is morphology (see Section 5.4). Regular, detailed monitoring is in place (and will continue) to confirm this. Thus, no adverse effect on site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Tidal regime and flows	No decrease in tidal range subject to natural processes. Tidal currents should not deviate significantly from an established baseline subject to natural processes. Riverine flows (Rivers Wye, Usk and Severn) and estuarine flows must be sufficient to ensure Water Framework Directive (WFD) target of Good Ecological Status (GES) is met.	Overall, it is considered highly unlikely that the continued extraction of aggregate from Bedwyn Sands and NMG Licence Renewal Areas, will result in any LSE on the physical processes of the wider study area. Tidal range is not predicted to be affected, nor are riverine flows. Whilst some changes local to the Renewal Areas are predicted, tidal flows will not significantly change in the wider study area (see Section 5.4). As such, no adverse effect on site integrity is anticipated as a result of any potential changes to tidal regime and flows within the estuary.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Sediment Budget	No decrease in sediment budget from the established baseline.	A sediment budget for the Middle Grounds (including NMG) has calculated that the average volume of the area is 1.8 billion m^3 (see Section 5.2). This is several orders of magnitude greater than the presently permitted extraction volume. Also, as noted in Section 5.4, monitoring has to date not revealed an ongoing negative trend due to the aggregate extraction currently taking place at the three licence areas on the NMG, and there is believed to be some (limited) sediment input into the system related to winter storms (see Section 5.4). No adverse effect to the sediment budget is predicted, meaning that no adverse effect on site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Sediment size, range and distribution	Sediment size distribution should not deviate from an established baseline.	Cargo gradings taken at Area 470 and ongoing PSA monitoring at Bedwyn Sands and NMG indicate that the sediment continues to be generally sandy in nature. In addition, there are no predicted significant changes to tidal regime nor sediment transport (see Section 5.4). Given this and established industry best practice measures, no adverse effect of site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Water quality-physio-chemical parameters	Physio-chemical parameters should not pose a risk to the ecology of the habitats and species of the SAC, SPA and Ramsar. Levels should comply with targets established under the EA Review of Consents and the WFD.	The overall impact on existing water quality has been assessed as insignificant (see Section 6.3). As such, no adverse effect on site integrity is anticipated as a result of physio-chemical parameters of water quality.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Phytoplankton	Growth of phytoplankton does not cause an undesirable disturbance to the estuary habitats and species. Levels should comply with targets established under the EA Review of the Consents and the WFD.	Not applicable as it is considered that there is no potential for an impact pathway between the scheme and phytoplankton.				

<table>
<tr><th colspan="4">Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)</th><th colspan="4">Summary of EIA Findings Following EIA Significance Criteria</th><th rowspan="2">Initial Conclusions on Favourable Condition Target</th></tr>
<tr><th>Feature</th><th>Sub-feature</th><th>Attribute</th><th>Target</th><th>Potential Effect (and Section of ES)</th><th>Preventative Measures</th><th>Mitigation</th><th>Significance of Residual Impact</th></tr>
<tr><td></td><td></td><td>Macroalgae</td><td>Average macroalgal cover and density should not compromise the ecology of the estuary habitats and species.

Levels should comply with targets established under the EA Review of the Consents and the WFD.</td><td colspan="5">Not applicable as it is considered that there is no potential for an impact pathway between the scheme and macroalgae within the estuary.</td></tr>
<tr><td></td><td></td><td>Toxic contaminations</td><td>Toxic contaminants in water column and sediment should be below levels which would pose a risk to the ecology of the estuary habitats and species.

Levels should comply with targets established under the EA Review of the Consents and the WFD.</td><td>The overall potential change to toxic contamination levels has been assessed as insignificant (see Section 6.3.3). As such, no adverse effect on site integrity is anticipated as a result of toxic contamination.</td><td>Best practice procedures and standard mitigation measures (Section 3.5).</td><td>-</td><td>-</td><td>No failure of target given the predicted scale of change</td></tr>
<tr><td></td><td></td><td>Airborne nutrient and contaminants</td><td>No exceedance of critical loads for:
Sulphur dioxide - 20 µg/m^3
Nitrous Oxides - 30 µg/m^3
Ozone - 3000 ppb
Ammonia - 3 µg/m^3
Nutrient Nitrogen - 30-40 kg/ha/yr.</td><td>The overall change to air quality has been assessed as insignificant (see Section 16.3). As such, no adverse effect on site integrity is anticipated as a result of airborne contamination.</td><td>Best practice procedures and standard mitigation measures (Section 3.5).</td><td>-</td><td>-</td><td>No failure of target given the predicted scale of change</td></tr>
<tr><td></td><td>Subtidal sandbanks</td><td rowspan="4">Extent, variety and spatial distribution of estuarine habitat communities</td><td colspan="6" rowspan="4">These are assessed as separate 'features' below.</td></tr>
<tr><td></td><td>Intertidal mudflat and sandflat communities</td></tr>
<tr><td></td><td>Atlantic salt meadow (and associated transition habitats)</td></tr>
<tr><td></td><td>Reefs of Sabellaria alveolata</td></tr>
<tr><td></td><td rowspan="3">Hard substrate habitats and their notable communities</td><td>Extent and variety</td><td>No decrease in extent or range of types of hard substrate habitats and their notable communities from the established baseline subject to natural processes.</td><td colspan="5" rowspan="3">Not applicable as it is considered that there is no potential for an impact pathway between the scheme and hard substrate habitats and their notable communities within the estuary (see Figure 8-1 in Section 8).</td></tr>
<tr><td></td><td>Spatial Distribution</td><td>Macroscale distribution of notable communities should not deviate significantly from the established baselines subject to natural processes.</td></tr>
<tr><td></td><td>Community composition</td><td>No decline in community quality due to changes in species composition or loss of typical species from an established baseline.</td></tr>
<tr><td></td><td>Assemblage of fish species</td><td>Abundance</td><td>No significant reduction in overall diversity of species or in individual populations against an established baseline.</td><td>Given the highly localised, small scale changes predicted as part of the dredging and the mobile nature of fish, no adverse effects are anticipated for the general assemblage (see Section 9.3); for sandeel there is a potential for insignificant to minor adverse localised impacts due to direct removal/ entrainment by the dredger draghead (see Section 9.3.4). However, this is not considered to be of a scale so as to have an adverse effect on site integrity related to the assemblage of fish species.</td><td>Best practice procedures and standard mitigation measures (Section 3.5).</td><td>-</td><td>-</td><td>No failure of target given the predicted scale of change</td></tr>
<tr><td></td><td>Assemblage of waterfowl Species</td><td>Abundance</td><td>No significant reduction in overall diversity of species or in individual populations against an established baseline.</td><td colspan="5">See Table C-3.</td></tr>
<tr><td></td><td rowspan="2">Assemblage of vascular plant species</td><td>Abundance of saltmarsh species</td><td>No significant reduction in overall diversity of species or in individual populations against an established baseline.</td><td colspan="5" rowspan="2">This is assessed as a separate 'feature' below.</td></tr>
<tr><td></td><td>Abundance of Eel grass</td><td>No significant reduction in overall diversity of species or in individual populations against an established baseline.</td></tr>
<tr><td>Subtidal Sand-banks</td><td>All Sub-features</td><td>Extent of feature</td><td>No decrease in extent of subtidal sandbanks features from an established baseline, subject to natural processes.</td><td>Change is considered to be short lived and limited in both magnitude and extent. This is due to the dynamic nature of the system, generally returning the bed to its pre-dredged condition very quickly (often within a single tide). As such no significant effects are predicted (see Sections 5.4, 8.3). As such, no adverse effect on site integrity is anticipated.</td><td>Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).</td><td>-</td><td>-</td><td>No failure of target given the predicted scale of change</td></tr>
</table>

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Sub-feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
		Extent of subtidal sandbank communities	No decrease in extent of the communities from an established baseline subject to natural processes.	The area is species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and so are disturbance-tolerant, have high recoverability rates and are capable of rapidly recolonizing disturbed habitats (see Section 8.3), and as such no adverse effect on site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Distribution of subtidal sandbank communities	No significant change in the macro scale distribution of the communities from an established baseline subject to natural processes.	The area is species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and so are disturbance-tolerant, have high recoverability rates and are capable of rapidly recolonizing disturbed habitats (see Section 8.3), and as such no adverse effect on site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Community composition	No decline in community quality due to changes in species composition or loss of typical species from an established baseline subject to natural processes.	The area is species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and so are disturbance-tolerant, have high recoverability rates and are capable of rapidly recolonizing disturbed habitats (see Section 8.3), and as such no adverse effect on site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Sediment character	No major change in composition of sediment type across the feature against an established baseline subject to natural processes.	Cargo gradings taken at Area 470 and ongoing PSA monitoring at Bedwyn Sands and NMG indicate that the sediment continues to be generally sandy in nature. In addition, there are no predicted significant changes to tidal regime nor sediment transport (see Section 5.4). Given this and established industry best practice measures, no adverse effect of site integrity is anticipated.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Topography	No major alteration of topography of the subtidal sandbank feature against an established baseline.	Regular, monitoring has to date not revealed an ongoing negative trend due to the aggregate extraction currently taking place at Bedwyn Sands and NMG, and there is believed to be some (limited) sediment input into the system related to winter storms (see Section 5.4). As such no adverse effect on site integrity is anticipated as a result of any changes to subtidal sandbank topography.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
Mudflats and sandflats	All Sub-features	Extent of the feature	No decrease in extent from an established baseline, subject to natural processes.	The targeted material is sand and as such mudflats will not be dredged. Potential impacts to sandflats is considered to be limited in both magnitude and extent and impact is likely to be shorted lived with the dynamic nature of the system returning the bed to its pre-dredged condition within a single tide. Therefore no significant adverse effects are anticipated (see Sections 5.4, 8.3). As such no adverse effect on site integrity is anticipated as a result of the extent of the mudflats and sandflats.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Extent and variety of the mudflats and sandflats communities	No decrease in the extent or range of types of communities from an established baseline, subject to natural processes.	The targeted material is sand and as such mudflats will not be dredged. The sandflats are species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and as such are disturbance-tolerant, have high recoverability rates and capable of rapidly	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Sub-feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
				recolonizing disturbed habitats (see Section 8.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on extent and variety of the mudflats and sandflats communities.				
		Distribution of mudflats and sandflats communities	Macro scale distribution of communities should not deviate significantly from an established baseline, subject to natural processes.	The targeted material is sand and as such mudflats will not be dredged. The sandflats are species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and so are disturbance-tolerant, have high recoverability rates and capable of rapidly recolonizing disturbed habitats (see Section 8.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on the distribution of the mudflats and sandflats communities.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Community composition	No decline in community quality due to changes in species composition or loss of typical species from an established baseline, subject to natural processes.	The targeted material is sand and as such mudflats will not be dredged. The sandflats are species poor. The species that are present are well adapted to living in a dynamic and disturbed tide swept environment and so are disturbance-tolerant, have high recoverability rates and capable of rapidly recolonizing disturbed habitats (see Section 8.3). As such no adverse effect on site integrity is anticipated as a result of any potential changes to mudflats and sandflats community composition.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Topography	Intertidal profile should not deviate significantly from an established baseline, subject to natural processes.	Regular, monitoring has to date not revealed an ongoing negative trend due to the aggregate extraction currently taking place at Bedwyn Sands and NMG, and there is believed to be some (limited) sediment input into the system related to winter storms (see Section 5.4). As such no adverse effect on site integrity is anticipated as a result of any changes to the topography.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Sediment character	Average particle size analysis parameters should not deviate significantly from an established baseline.	Ongoing PSA monitoring has shown that the sediment continues to be generally sandy in nature. Therefore no significant adverse effects are anticipated (see Section 5.4). As such no adverse effect on site integrity is anticipated as a result of any changes to sediment character.	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
			Average organic carbon content should not deviate significantly from an established baseline.	Area is naturally not made of organic rich material. Given the predominant sediment type and well mixed nature of the Severn Estuary, no adverse effect on site integrity is anticipated (see Section 6.3).	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
			Average black layer depth should not deviate significantly from an established baseline.	Area is naturally not made of organic rich material. Given the predominant sediment type and well mixed nature of the Severn Estuary, no adverse effect on site integrity is anticipated (see Section 6.3).	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5).	-	-	No failure of target given the predicted scale of change
Atlantic salt meadows	All sub-features	Extent of the Atlantic salt meadow	No decrease in extent of Atlantic salt meadow and associated transitional vegetation communities from the established baseline subject to natural processes.	Not applicable as the predicted scale of change caused by the dredging activity is not expected to cause any potential impacts to intertidal saltmarshes (see Section 5.4 and 8.3). Both the Middle and Welsh Grounds provide a sheltering effect to the intertidal and saltmarsh habitats in the lee of the banks.				

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Sub-feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
		communities and associated transitional vegetation communities		The bank morphology is not considered to be impacted by aggregate dredging activities (alone or in combination) and therefore no reduction in this sheltering effect is expected.				
		Extent of the Atlantic salt meadow communities and associated transitional vegetation communities	No decrease in extent of Atlantic salt meadow and associated transitional vegetation communities from the established baseline subject to natural processes.					
		Distribution of the Atlantic salt meadow communities and associated transitional vegetation communities	The macro scale distribution of communities should not deviate significantly from an established baseline subject to natural processes.					
		Extent of *Spartina anglica*	No increase in total extent of more than 10% over monitoring period.					
		Zonation of vegetation	The range of variation of zonation of saltmarsh communities around the estuary should not deviate significantly from an established baseline, subject to natural processes.					
		Species composition	Frequency of typical species of characteristic low to mid marsh communities should not deviate significantly from an established baseline.					
			Frequency of typical species of characteristic mid to upper marsh communities should not deviate significantly from an established baseline.					
			Frequency of typical species of characteristic high marsh communities should not deviate significantly from an established baseline.					
			Frequency of typical species of characteristic pioneer marsh communities should not deviate significantly from an established baseline.					
		Abundance of locally occurring scarce and notable plant species	No decrease in abundance of scarce and notable species from an established baseline.					
		Sward structure	The extent and distribution of vegetation communities exhibiting different sward heights should not deviate significantly from an established set of limits. The limits will be defined to ensure that the requirements of the typical and notable plants species and birds species designated within the Severn Estuary SPA and Ramsar, can be met.					
		Morphology	No anthropogenic alteration of established morphological features from an established baseline.					
Reefs		(Total) Extent and distribution	No reduction in the extent and distribution of the reef from an established baseline.	*Sabellaria* reefs are present within the wider estuary, however, these have not been recorded within the Renewal Areas. *D*ue to their substratum preference, it would be highly unlikely for *Sabellaria* reefs to be located on the sandy substrate within the Renewal Areas (Section 8.3). It is considered that *Sabellaria alveolata* aggregations in such a highly dynamic environment, would be best considered as naturally ephemeral features should they ever be	Best practice procedures and standard mitigation measures, including continuation of established monitoring throughout the duration of the renewed licence period (Section 3.5). Implementation of non-dredging exclusion zones if reefs identified (including buffer).	-	-	No failure of target given the predicted scale of change
		Community composition	New samples of reef show no significant decline in community composition from baseline records.					
		Age structure	Different phases from newly settled worms through vigorous fast growing reef to older hummocks are present.					
		Physical and ecological processes	No change in the abundance of suitable sediments grades within the defined reef zones against an established baseline.					
			No change in overall extent of available suitable substrates within the defined reefs zone against an established baseline.					

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	**Sub-feature**	**Attribute**	**Target**	**Potential Effect (and Section of ES)**	**Preventative Measures**	**Mitigation**	**Significance of Residual Impact**	
			No decrease in the abundance of *Sabellaria* larvae against an established baseline.	found to occur within the Renewal Areas. If found ,*Sabellaria* reefs would be surrounded by sufficiently proportioned exclusions zones (in consultation with regulators) (Section 8.3).				
			No decrease in the abundance of suspended detritus within the water column of the defined reef zone against an established baseline.					
River Lamprey (*Lampetra fluviatilis*) and Sea Lamprey (*Petromyzon marinus*)		Migratory access (Barriers to migration)	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity, pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the WFD.	Given a limited sensitivity to high suspended sediment loads, together with the localised, small scale changes of water quality predicted as part of the dredging and the mobile nature of lamprey, no adverse effects are anticipated (Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
			Flows from the river into the estuary must be sufficient to allow migration.	Not applicable as the continuation of dredging at Bedwyn Sands and NMG will have no impact on any rivers flowing into the estuary therefore no adverse effects on site integrity as a result of lamprey migration is anticipated (see Section 5).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
			No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream.	The only potential for a barrier to occur for migrating lamprey is via changes to SSC. Any change to SSC is considered to be a of similar magnitude to those which occur naturally as a result of variation in tidal conditions, therefore no adverse effects on site integrity are anticipated (see Section 9.3.2)	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Population size	No decline in number of returning adults from established baseline.	Given the highly localised, small scale changes of water quality (Section 9.3.2) and noise levels (Section 9.3.3) predicted as part of the dredging and the mobile nature of lamprey, no adverse effects on site integrity are anticipated (see Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Ammocoete population in tributary rivers	River population targets for the Usk and Wye must be met.	The wider study area does not overlap with rivers and as such no potential impact pathways to the ammocoete population in the tributary rivers have been identified.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Prey species	No significant reduction in abundance of key prey species against an established baseline.	Bedwyn Sands and NMG comprises an impoverished habitat and so provides a limited prey resource for lampreys. No significant change to food chains is anticipated, therefore no adverse effects are predicted (see Section 9.3.1)	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
Twaite Shad (*Alosa fallax*)		Migratory access (barrier to movement)	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity, pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the WFD.	Given the insignificant changes to water quality predicted and the tolerance of shad to changes in turbidity, no adverse effects are anticipated (Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
			Flows from the river into the estuary must be sufficient to allow migration	Not applicable as the continuation of dredging at Bedwyn Sand and NMG will have no impact to any rivers flowing into the estuary therefore no adverse effects to shad migration are anticipated (see Section 5).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
			No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream.	Barriers that could occur for migrating shad include changes to SSC and noise. Any change to SSC is considered to be of similar magnitude to those which occur naturally as a result of variation in tidal conditions. Although shad are classified as being sensitive to noise, the overall exposure and magnitude of noise levels associated with dredging are considered to be negligible (Section 9.3.3). Therefore no adverse effects on site integrity are anticipated.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Sub-feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
		Population size (returning adults)	No drop in the annual run size greater than would be expected from variations in natural mortality alone	Given the highly localised, small scale changes predicted as part of the dredging and the mobile nature of fish, no adverse effects on site integrity are anticipated (see Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		River population	River population targets for the Usk and Wye must be met	The wider study area does not overlap with the rivers and as such no potential impact pathways have been identified to shad populations in the rivers.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Prey species	No significant reduction in abundance of key prey species against an established baseline	Juvenile twaite shad feed on invertebrates and estuarine zooplankton. As they develop they start to feed on crustaceans and small fish (Maitland and Hatton-Ellis, 2003). Bedwyn Sands and NMG comprise an impoverished habitat and so provide a limited prey resource for Twaite shad. Changes to food chains is considered to be negligible and no adverse effects on site integrity are anticipated (see Section 9.3.1)	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

Table C-3 Favourable condition table for Severn Estuary/ Môr Hafren SPA

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Supporting Habitat	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Internationally important Annex 1 species: Bewick's swan	Saltmarsh	Habitat extent	At The Dumbles, no decrease in extent from 76 ha	See Atlantic Saltmarsh feature in Table C-2.				
		Vegetation characteristics	Greater than 25% cover during the winter season.					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines. Areas of vegetation with an effective field size of >6 ha					
	Intertidal mudflats and sandflats	Habitat extent	At Frampton Sands, Waveridge Sands and the Noose, no decrease in extent from 980 ha.	See Atlantic intertidal mudflats and sandflats feature in Table C-2.				
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.					
	Internationally important Annex 1 species: Bewick's swan	Population size	No less than 289 individuals [i.e. the 5 year peak mean between 1988/9 - 1992/3]	The study area is only used by very low numbers of waterbirds and marine birds. Due to the negligible exposure of birds to the potential impacts, all potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on Bewicks Swan.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Proportion of biogeographic population	1% of NW European population	The dredging will not change the overall extent of the intertidal habitat which is available as a feeding resource for water birds and the area provides a limited prey resource for feeding waterbirds (see Section 10.3). The study area is only used by very low numbers of waterbirds and marine birds. All associated potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on Bewicks Swan.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Distribution	No decrease in use of the number of sectors and their distribution established as baseline	The dredging will not change the overall extent of the intertidal habitat which is available as a feeding resource for water birds and the area provides a limited prey resource for feeding waterbirds (see Section 10.3). The study area is only used by very low numbers of waterbirds and marine birds. All associated potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on Bewick's Swan.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Disturbance in feeding and roosting areas	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline.	The site is a low water feeding site and has a limited function as a roosting site as the mud and sandflats are covered at high water. Any dredging activity will take place at high water therefore there will be no disturbance to birds feeding and roosting. All associated potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of any potential impacts on Bewick's Swan.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
Internationally important populations of regularly occurring migratory species and Internationally important assemblage of waterfowl	Saltmarsh	Habitat extent	No decrease in extent from 1,400 ha. At The Dumbles, no decrease in extent from 76 ha.	See Atlantic Saltmarsh feature in Table C-2.				
		Food availability	Presence and abundance suitable saltmarsh food plants should not deviate significantly from an established baseline					
		Vegetation characteristics	Sward height and density throughout areas used for roosting should not deviate significantly from an established baseline					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.					
	Intertidal mudflats and sandflats	Habitat extent	No decrease in extent from 15,000 ha. At Frampton Sands, Waveridge Sands and The Noose no decrease in extent from 980 ha.	See intertidal mudflats and sandflats feature in Table C-2.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

Summary of Natural England and Countryside Council Wales Conservation Objectives (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Supporting Habitat	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
assemblage of waterfowl		Food availability	Presence and abundance of suitable prey species should not deviate significantly from an established baseline	This habitat provides a limited prey resource for feeding waterbirds. The benthic species which are present in the sand are well adapted to dynamic sand environments and so any infaunal prey items present would be expected to rapidly colonise the area following dredging. As such no adverse effect on site integrity is anticipated (see Section 10.3.1).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.	Not applicable as dredging activity will only occur at high water when the mudflats and sandflats are covered and so will not be used as a feeding or roosting site.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Shingle and rocky shores	Habitat extent	No decrease in extent from 1,500 ha.	Not applicable as there is no potential for an impact pathway between the dredging at Bedwyn Sands and NMG and the shingle and rocky shores within the estuary (see Section 8.2).				
		Food availability	Presence and abundance of suitable food species should not deviate significantly from an established baseline					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.					
	Internationally important populations of regularly occurring migratory species And Internationally important assemblage of waterfowl	Population size	No less than 68,026 individuals in the assemblage [i.e. the 5 year peak mean between 1988/9 - 1992/3]. For individual species - no less than the 5 year peak mean between 1988/9 - 1992/3 detailed in Table 4.	The study area is only used by very low numbers of waterbirds and marine birds and there are no predicted impacts. All associated potential impact pathways have been assessed as insignificant (see Section 10.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Distribution	No decrease in use of the number of sectors and their distribution established as baseline.	The dredging will not change the overall extent of the intertidal habitat which is available as a feeding resource for water birds and there is limited prey resource for feeding waterbirds (see Section 10.3). The study area is only used by very low numbers of waterbirds and marine birds and the application is for no change is usage of the area. All associated potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of potential impacts on the distribution of Internationally important populations of regularly occurring migratory species and internationally important assemblage of waterfowl.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
		Disturbance in feeding and roosting areas	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline	The site is a low water feeding site and has a limited function as a roosting site as the mud and sandflats are covered at high water. Any dredging activity will take place at high water therefore there will be no disturbance to birds feeding and roosting. All associated potential impact pathways have been assessed as insignificant (see Section 10.3). As such no adverse effect on site integrity is anticipated as a result of potential impacts on the distribution of Internationally important populations of regularly occurring migratory species and Internationally important assemblage of waterfowl.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

Table C-4 Favourable condition table for Severn Estuary/ Môr Hafren Ramsar

Summary of Conservation Objectives for Qualifying Features (Natural England and CCW, 2009)				Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Supporting Habitat	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Estuaries	Largely the same as that for the Severn Estuary / Môr Hafren SAC, however, the estuarine ecosystem designated as Ramsar Sites is smaller than that of the SAC as it is restricted to the terrestrial and intertidal areas and excludes all subtidal areas. See 'Estuaries' feature in Table C-2 for details.							
Migratory fish assemblage		Migratory access (Barriers to migration)	Water quality is sufficient to support migratory passage. Levels (for temperature, salinity, turbidity and pH, and dissolved oxygen) should comply with targets established under the EA Review of Consents and the Water Framework Directive.	See 'sea lamprey', 'river lamprey' and 'twaite shad' features in Table C-2.				
			Flows from the rivers into the estuary must be sufficient to allow migration					
			No artificial barriers significantly impairing, adults from reaching existing and historical spawning grounds, or juveniles from moving downstream.					
		Population size	No decline in number of returning adults from established baseline					
		River populations	No decline in populations of the Rivers Wye and Usk					
		Prey species	No significant reduction in abundance of key prey species against an established baseline					
Internationally important populations of waterfowl and Internationally important assemblage of waterfowl	Saltmarsh	Habitat extent	No decrease in extent from 1,400 ha. At The Dumbles, no decrease in extent from 76 ha.	See 'Atlantic saltmarsh' feature in Table C-2.				
		Food availability	Presence and abundance of suitable saltmarsh food plants should not deviate significantly from an established baseline					
		Vegetation characteristics	Greater than 25% cover during the winter season.					
			Sward height and density throughout areas used for roosting should not deviate significantly from an established baseline					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines. Areas of vegetation with an effective field size of >6 ha at the Dumbles (Bewicks swan)					
	Intertidal mudflats and sandflats	Habitat extent	No decrease in extent from 15,000 ha. At Frampton Sands, Waveridge Sands and The Noose no decrease in extent from 980 ha.	See 'Intertidal mudflat and sandflat' feature in Table C-2.				
		Food availability	Presence and abundance of suitable prey species should not deviate significantly from an established baseline					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.					
	Shingle and rocky shores	Habitat extent	No decrease in extent from 1,500 ha.	See 'Shingle and rocky shores' feature in Table C-2.				
		Food availability	Presence and abundance of suitable food species should not deviate significantly from an established baseline					
		Unimpeded sightlines at feeding and roosting sites	No increase in obstructions to existing bird sightlines.					
		Population size	No less than 68,026 individuals in the assemblage [i.e. the 5 year peak mean between 1988/9 - 1992/3] For individual species - no less than the 5 year peak mean between 1988/9 - 1992/3	See 'waterbird assemblage' feature in Table C-3.				
		Distribution	No decrease in use of the number of sectors and their distribution established as baseline					
		Disturbance in feeding and roosting areas.	No significant reduction in numbers or displacement of wintering birds attributable to disturbance from an established baseline					

Table C-5 Favourable condition table for the River Usk/ Afon Wysg SAC

Summary of Conservation Objectives for Qualifying Features (NRW, 2022a)			Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Sea lamprey *Petromyzon marinus*	Distribution within catchment	Suitable habitat adjacent to or downstream of known spawning sites should contain *Petromyzon* ammocoetes.	See 'Sea Lamprey' feature in Table C-2.				
	Ammocoete density	Ammocoetes should be present in at least four sampling sites each not less than 5 km apart. Overall catchment mean >0.1 m^{-2}					
River lamprey *Lampetra fluviatilis*	Age/size structure of ammocoete population	Samples < 50 ammocoetes ~ 2 size classes Samples > 50 ammocoetes ~ at least 3 size classes.	See 'River Lamprey' feature in Table C-2.				
	Distribution of ammocoetes within catchment	Present at not less than 2/3 of sites surveyed within natural range No reduction in distribution of ammocoetes					
	Ammocoete density	Optimal habitat: >10 m^{-2} Overall catchment mean: >5 m^{-2}					
Twaite shad *Alosa fallax*	Spawning distribution	No decline in spawning distribution	See 'Twaite shad' feature in Table C-2.				
	Flow	Targets are set in relation to river/reach type(s)					
Allis shad *Alosa alosa*	Spawning distribution	No decline in spawning distribution	The wider study area does not overlap with the River Usk and as such no potential impact pathways have been identified to Allis shad populations in the river.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Flow	Targets are set in relation to river/reach type(s)	Not applicable as the continuation of dredging at Bedwyn Sand and NMG will have no impact to any rivers flowing into the estuary therefore no adverse effects to shad migration are anticipated (see Section 5).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
Atlantic salmon *Salmo salar*	Adult run size	Conservation Limit complied with at least four years in five	Given the highly localised, small-scale changes predicted as part of the dredging and the mobile nature of fish, no adverse effects on site integrity are anticipated (see Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Juvenile densities	Expected densities for each sample site using HABSCORE	Given the highly localised, small-scale changes predicted as part of the dredging and the mobile nature of fish, no adverse effects on site integrity are anticipated (see Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Water quality	See Appendix 2 of NRW (2022a)	Given the insignificant changes to water quality predicted and the tolerance of Atlantic salmon to changes in turbidity, no adverse effects are anticipated (Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Flow	Targets are set in relation to river / reach type(s)	Not applicable as the continuation of dredging at Bedwyn Sand and NMG will have no impact to any rivers flowing into the estuary therefore no adverse effects to Atlantic salmon migration are anticipated (see Section 5).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

Table C-6 Favourable condition table for the River Wye/ Afon Gwy SAC – Wales

Summary of Conservation Objectives for Qualifying Features (NRW, 2022b)			Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Attribute	Target	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Sea lamprey *Petromyzon marinus*	Distribution within catchment	Suitable habitat adjacent to or downstream of known spawning sites should contain *Petromyzon* ammocoetes.	See 'Sea Lamprey' feature in Table C-2.				
	Ammocoete density	Ammocoetes should be present in at least four sampling sites each not less than 5 km apart.					
River lamprey *Lampetra fluviatilis*	Age/size structure of ammocoete population	Samples of < 50 ammocoetes contain at least 2 size classes Samples of > 50 ammocoetes contain at least 3 size classes	See 'River Lamprey' feature in Table C-2.				
	Distribution of ammocoetes within catchment	Present at not less than 2/3 of sites surveyed within natural range No reduction in distribution of ammocoetes					
	Ammocoete density	Optimal habitat: >10 m^{-2} Overall catchment mean: >5 m^{-2}					
Twaite shad *Alosa fallax*	Spawning distribution	No decline in spawning distribution	See 'Twaite shad' feature in Table C-2.				
	Flow	Targets are set in relation to river/reach type(s)					
Allis shad *Alosa alosa*	Spawning distribution	No decline in spawning distribution	See 'Allis shad' feature in Table C-5.				
	Flow	Targets are set in relation to river/reach type(s)					
Atlantic salmon *Salmo salar*	Adult run size	Conservation Limit complied with at least four years in five	See 'Atlantic salmon' feature in Table C-5.				
	Juvenile densities	Expected densities for each sample site using HABSCORE					
	Biological quality	Biological GQA class A	Given the insignificant changes to water quality predicted and the tolerance of Atlantic salmon to changes in turbidity, no adverse effects are anticipated (Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Chemical quality	Water quality targets in CSM guidance for Rivers (NRW, 2022b)	Given the insignificant changes to water quality predicted and the tolerance of Atlantic salmon to changes in turbidity, no adverse effects are anticipated (Section 9.3).	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Flow	Targets are set in relation to river / reach type(s)	See 'Atlantic salmon' feature in Table C-5.				

Table C-7 Favourable condition table for the River Wye SAC – England

Summary of Conservation Objectives for Qualifying Features (Natural England, 2018; 2022)		Summary of EIA Findings Following EIA Significance Criteria				Initial Conclusions on Favourable Condition Target
Feature	Attribute (maintain or restore)	Potential Effect (and Section of ES)	Preventative Measures	Mitigation	Significance of Residual Impact	
Migratory fish (sea lamprey *Petromyzon marinus* (1095); river lamprey *Lampetra fluviatilis* (1099); twaite shad *Alosa fallax* (1103); Allis shad *Alosa alosa* (1102); and Atlantic salmon *Salmo salar* (1106))	Extent and distribution of qualifying natural habitats and habitats of qualifying species	See 'Sea Lamprey', 'River Lamprey' and 'Twaite Shad' in Table C-2. See 'Allis Shad' and 'Atlantic salmon' features in Table C-5.	Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Structure and function (including typical species) of qualifying natural habitats		Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Structure and function of the habitats of qualifying species		Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Supporting processes on which qualifying natural habitats and the habitats of qualifying species rely		Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Populations of qualifying species		Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change
	Distribution of qualifying species within the site		Best practice procedures and standard mitigation measures (Section 3.5).	-	-	No failure of target given the predicted scale of change

C.13 References

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NRW (2022a) Core Management Plan including Conservation Objectives for Afon Wysg/ River Usk SAC.

NRW (2022b) Core Management Plan including Conservation Objectives for Afon Gwy / River Wye SAC.

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D Water Framework Directive Assessment

D.1 Introduction

D.1.1 Project overview

Breedon Group wishes to reapply for marine licences to gain permissions to dredge aggregates from Bedwyn Sands and North Middle Ground (NMG) in the Severn Estuary (Figure D-1). Given the cross-border nature of Bedwyn Sands and NMG, two marine licences are required: one from the Marine Management Organisation (MMO) (the English authority) and the other from Natural Resources Wales (NRW) (the Welsh authority). Bedwyn Sands and NMG measure 9.4 km² and 10.4 km² respectively. The NMG Renewal Areas are within Welsh waters, whereas Bedwyn Sands is split, with 3.5 km² in Welsh waters and 1.9 km² in English waters.

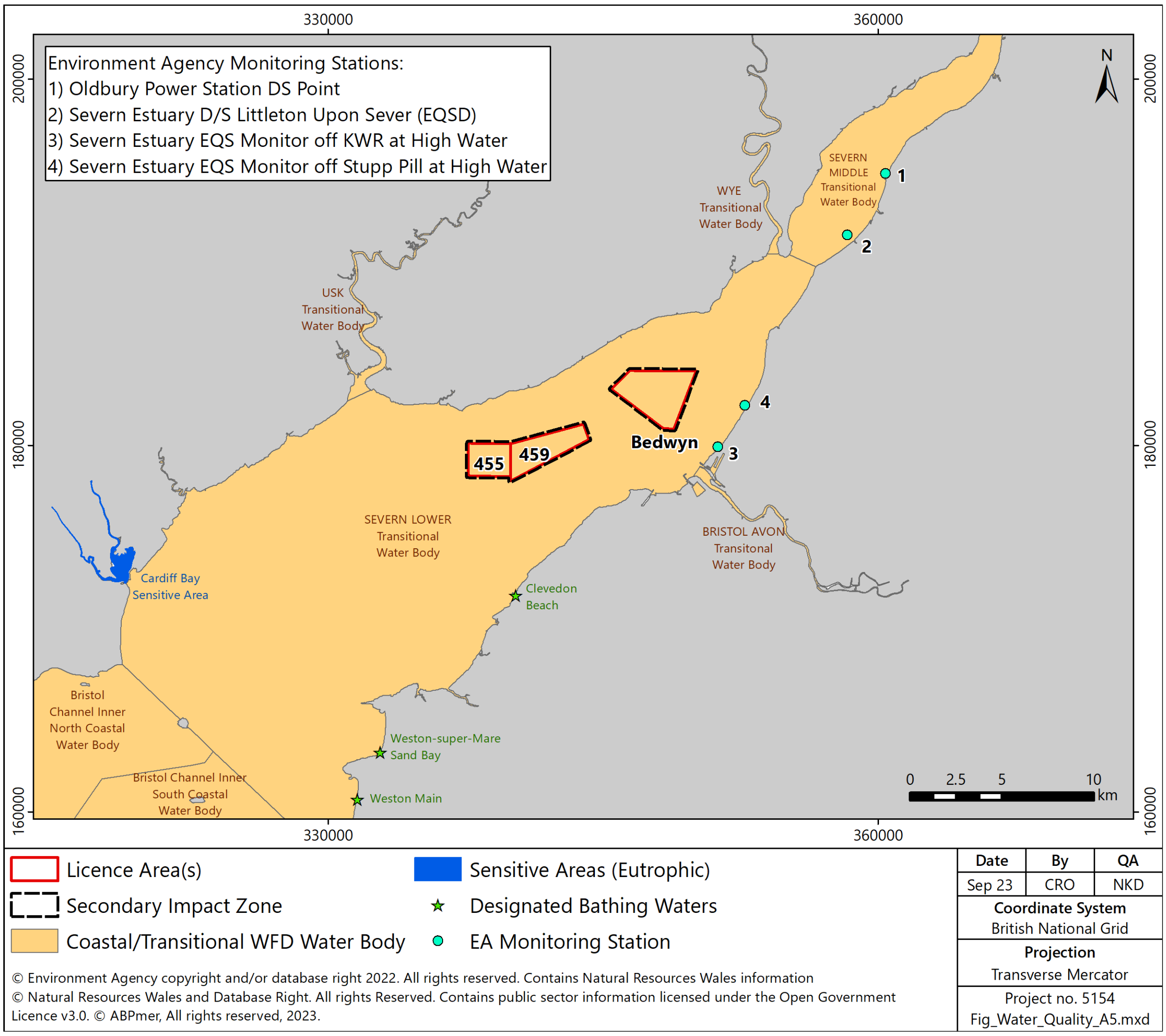

Figure D-1 Location of Bedwyn Sands and NMG within the Severn Lower transitional water body

ABPmer has been commissioned by Breedon Group to undertake a Water Framework Directive (WFD) compliance assessment to determine whether aggregate extraction from Bedwyn Sands and NMG, located within the Severn Lower transitional water body (Figure D-1), complies with the objectives of the WFD. This information, together with the Environmental Statement (ES) (see main report), will support the marine licence applications that will be submitted to the MMO and NRW as part of the marine licensing process.

D.1.2 Water Framework Directive

The WFD (2000/60/EC) came into force in 2000 and established a framework for the management and protection of Europe's water resources. It was implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017 (the Water Framework Regulations) (as amended). The overall objective of the WFD is to achieve good status (GS) in all inland, transitional, coastal and ground waters by 2021, unless alternative objectives are set and there are appropriate reasons for time limited derogation. While the UK left the EU on 31 January 2020, the UK continues to be committed to meeting high environmental standards. The main provisions of the WFD have been retained in English law through the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.

The WFD divides rivers, lakes, lagoons, estuaries, coastal waters (out to one nautical mile from the low water mark), man-made docks and canals into a series of discrete surface water bodies. It sets ecological as well as chemical targets (objectives) for each surface water body. For a surface water body to be at overall GS, the water body must be achieving good ecological status (GES) and good chemical status (GCS). Ecological status is measured on a scale of high, good, moderate, poor or bad, while chemical status is measured as good or fail (i.e. failing to achieve good).

Each surface water body has a hydromorphological designation that describes how modified a water body is from its natural state. Water bodies are either undesignated (i.e. natural, unchanged), designated as a heavily modified water body (HMWB) or designated as an artificial water body (AWB). HMWBs are defined as bodies of water which, as a result of physical alteration by sustainable human use activities (such as flood protection and navigation) are substantially changed in character and cannot therefore meet GES. AWBs are artificially created through human activity. The default target for HMWBs and AWBs under the WFD is to achieve good ecological potential (GEP), a status recognising the importance of their human use while ensuring ecology is protected as far as possible.

The ecological status of surface waters is classified using information on the biological (e.g. fish, benthic invertebrates, phytoplankton, angiosperms and macroalgae), physico-chemical (e.g. dissolved oxygen (DO) and salinity) and hydromorphological (e.g. hydrological regime) quality of the body of water, as well as several specific pollutants (e.g. copper and zinc). Compliance with chemical status objectives is assessed in relation to environmental quality standards (EQS) for a specified list of 'priority' and 'priority hazardous' substances. These substances were first established by the Priority Substances Directive (PSD) (2008/105/EC) which entered into force in 2009. The PSD sets objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions.

As required by the WFD and PSD, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated PSD (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting biota EQSs for some existing and newly identified priority substances. The updated PSD is transposed into UK legislation through the Water Environment (WFD) (England and Wales) (Amendment) Regulations 2015, which entered into force in September 2015, and explained in the WFD (Standards and Classification) Directions (England and Wales) 2015.

In addition to surface water bodies, the WFD also incorporates groundwater water bodies. Groundwaters are assessed against different criteria compared to surface water bodies since they do not support ecological communities (i.e. it is not appropriate to consider ecological status of a groundwater). Therefore, groundwater water bodies are classified as good or poor quantitative status in terms of their quantity (groundwater levels and flow directions) and quality (pollutant concentrations and conductivity), along with chemical (groundwater) status.

River Basin Management Plans (RBMPs) are a requirement of the WFD, setting out measures for each river basin district to maintain and improve quality in surface and groundwater water bodies where necessary. In 2009, the Environment Agency published the first cycle (2009 to 2015) of RBMPs for England and Wales, reporting the status and objectives of each individual water body. The Environment Agency and NRW subsequently published updated RBMPs for England and Wales as part of the second cycle (2015 to 2021), as well as providing water body classification results from 2015 and Cycle 2 interim classifications via the Catchment Data Explorer and Water Watch Wales websites, respectively. Cycle 3 has now been. The latest updates to RBMPs took place in December 2022, and this third stage of the RBMP approach to water body management covers the period from 2022 to 2027.

Bedwyn Sands and NMG are located within the Severn Lower transitional water body (see Figure D-1) in the Severn River Basin District which is reported in the Severn RBMP (Environment Agency, 2022; NRW, 2023).

Consideration of WFD requirements is necessary for works which have the potential to cause deterioration in ecological, quantitative and/or chemical status of a water body or to compromise improvements which might otherwise lead to a water body meeting its WFD objectives. Therefore, it is necessary to consider the potential for the proposed works to impact WFD water bodies, specifically referring to the following environmental objectives, as set out in Section 13 (Subsections 1 to 7) of the Water Framework Regulations:

- **For surface water bodies**, the objectives are to:
  (a) Prevent deterioration of the status of each body of surface water;
  (b) Protect, enhance and restore each body of surface water (other than an artificial or heavily modified water body) with the aim of achieving good ecological status and (…) good surface water chemical status, if not already achieved (…);
  (c) Protect and enhance each artificial or heavily modified water body with the aim of achieving good ecological potential and (…) good surface water chemical status, if not already achieved (…); and
  (d) Aim progressively to reduce pollution from priority substances and aim to cease or phase out emissions, discharges and losses of priority hazardous substances.
- **For shellfish water protected areas**, in addition to the [above] objectives (…) for the surface water bodies in which they are located, the objectives are such objectives as are necessary or desirable to improve or protect the shellfish water protected area in order to support shellfish life and growth and to contribute to the high quality of shellfish products suitable for human consumption as the appropriate authority may direct.
- **For groundwater bodies**, the objectives are to:
  (a) Prevent deterioration of the status of each body of groundwater;
  (b) Prevent or limit the input of pollutants into groundwater;
  (c) Protect, enhance and restore each body of groundwater, and ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater chemical status and good groundwater quantitative statusy, if not already achieved (…); and
  (d) Reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.

- **For each protected area**, other than a shellfish water protected area, the objective is to achieve compliance with any standards and objectives required by or under [the retained EU law] under which the area or body is protected:
  (a) By 22 December 2021, if not already achieved, or
  (b) If different, by any date for compliance set in [the relevant retained EU law].

Where two or more objectives set under this regulation apply to the same body of water, or the same part of a body of water, the most stringent objective applies.

The Environment Agency (2016) has published guidance ("Clearing the Waters for All") regarding how to assess the impact of activities in transitional and coastal waters for the WFD[17]. The guidance sets out the following three discrete stages to WFD assessments:

- **Screening**: excludes any activities that do not need to go through the scoping or impact assessment stages;
- **Scoping**: identifies the receptors that are potentially at risk from an activity and need impact assessment; and
- **Impact Assessment**: considers the potential impacts of an activity, identifies ways to avoid or minimise impacts, and indicates if an activity may cause deterioration or jeopardise the water body achieving GS.

D.2 Screening

D.2.1 Potentially affected water bodies

To determine which water bodies would potentially be affected by the Proposed Development, all surface and groundwater water bodies located within 2 km of Bedwyn Sands and NMG were recorded (Figure D-1).

Therefore, the following water bodies were screened in:

- Severn Lower transitional water body (ID: GB530905415401).

Table D-1 provides a summary of the Severn Lower transitional water body, within which Bedwyn Sands and NMG are located, including current water body status (overall, ecological and chemical) and parameters currently failing to achieve good status.

Bedwyn Sands and NMG Renewal Areas are located within the Severn River Basin District (Environment Agency, 2022), and overlap the Welsh Severn Lower transitional water body (ID: GB530905415401). The Severn Lower transitional water body is classified as a heavily modified water body (HMWB). This means 'ecological potential' is applied rather than 'ecological status'. The current (2021) overall status of the water body is 'moderate', based on 'moderate' ecological potential and 'moderate' chemical status (NRW, 2022). The reason for the 'moderate' ecological potential is based on biological quality elements 'invertebrates', 'angiosperms' (saltmarsh), and the supporting element 'mitigation measures assessment'. The 'moderate' chemical status is based on the priority hazardous substance 'mercury and its compounds'.

With respect to Welsh water bodies, the Wye (ID: GB530905415406) and Usk (ID: GB530905415404) transitional water bodies all flow into the Severn Lower transitional water body. Each of these water

17 https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters (Accessed September 2023).

bodies have a current (2021) overall status of 'moderate' status with a 'moderate' ecological potential and 'high' chemical status (NRW, 2022). The Severn Middle (ID: GB530905415402) and Bristol Avon (ID: GB530905415405) also flow into the into the Severn Lower transitional water bodies. Each of these have a 'moderate' ecological potential (based on the 2022 classification), and a chemical status of 'fail' (based on the 2019 classification, noting that the 2022 classification 'does not require assessment') (Environment Agency, 2023a) (see Section 6.2 of the ES for more detail).

Table D-1 Severn Lower transitional water body summary

Water Body Name	Severn Lower
Water Body ID	GB530905415401
Water Body Type	Transitional
Water Body Area	465.976 km² (surface area)
Hydromorphological Designation (Reasons for Designation)	Heavily modified (Flood protection)
Protected Area Designations	Habitats Directive Birds Directive Bathing Water Directive
Overall Status (2022)	Moderate
Ecological Status/Potential (2022)	Moderate
Chemical Status (2022)	Moderate
Parameters not at Good Status (2022)	Invertebrates Angiosperms Mitigation measures assessment Mercury and its compounds
Higher Sensitivity Habitats	Intertidal seagrass (2.64 km^2) Mussel beds (0.46 km^2) Polychaete reef (5.38 km^2) Saltmarsh (6.80 km^2)
Lower Sensitivity Habitats	Cobbles, gravel and shingle (0.31 km^2) Intertidal soft sediment (163.85 km^2) Subtidal soft Sediment (152.05 km^2) Rocky shore (22.93 km^2) Subtidal rocky reef (89.26 km^2)
Macroalgae Status	Unknown
History of Harmful Algae	Not monitored

The Severn Lower transitional water body flows into the Bristol Channel Inner North (GB641008660000) and the Bristol Channel Inner South (GB640807670000) coastal water bodies. The current (2021) overall status of the Bristol Channel Inner North water body is 'moderate', based on 'moderate' ecological status and 'high' chemical status (NRW, 2022). The current (2022) status of the Bristol Channel Inner South water body is a 'moderate' ecological status. The chemical status 'does not require assessment' in 2022, but it is noted that the water body had a chemical status of 'fail' in 2019 (Environment Agency, 2023a).

D.2.2 Protected areas

The WFD requires that activities are also in compliance with other relevant legislation, such as the Conservation of Habitats and Species Regulations 2017 (as amended), Bathing Water Regulations 2013 (as amended), Nitrate Pollution Prevention Regulations 2015 (as amended), Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended), and the provisions of the Shellfish Water Protected Areas (England and Wales) Directions 2016 (as amended).

The Conservation of Habitats and Species Regulations 2017 (as amended) transpose the Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC) into English law[18]. Article 3 of the Habitats Directive (92/43/EEC as amended) requires the establishment of a European network of important high-quality conservation sites known as Special Areas of Conservation (SAC) that will contribute to conserving habitats and species identified in Annexes I and II of the Directive. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).

In accordance with Article 4 of the Birds Directive (2009/147/EC), Special Protection Areas (SPA) are strictly protected sites classified for rare and vulnerable birds (Annex I of the Directive), and for regularly occurring migratory species. Ramsar sites are wetlands of international importance designated under the Ramsar Convention (adopted in 1971 and came into force in 1975), providing a framework for the conservation and wise use of wetlands and their resources.

See Figure D-2 for locations of nearby protected areas to Bedwyn Sands and NMG.

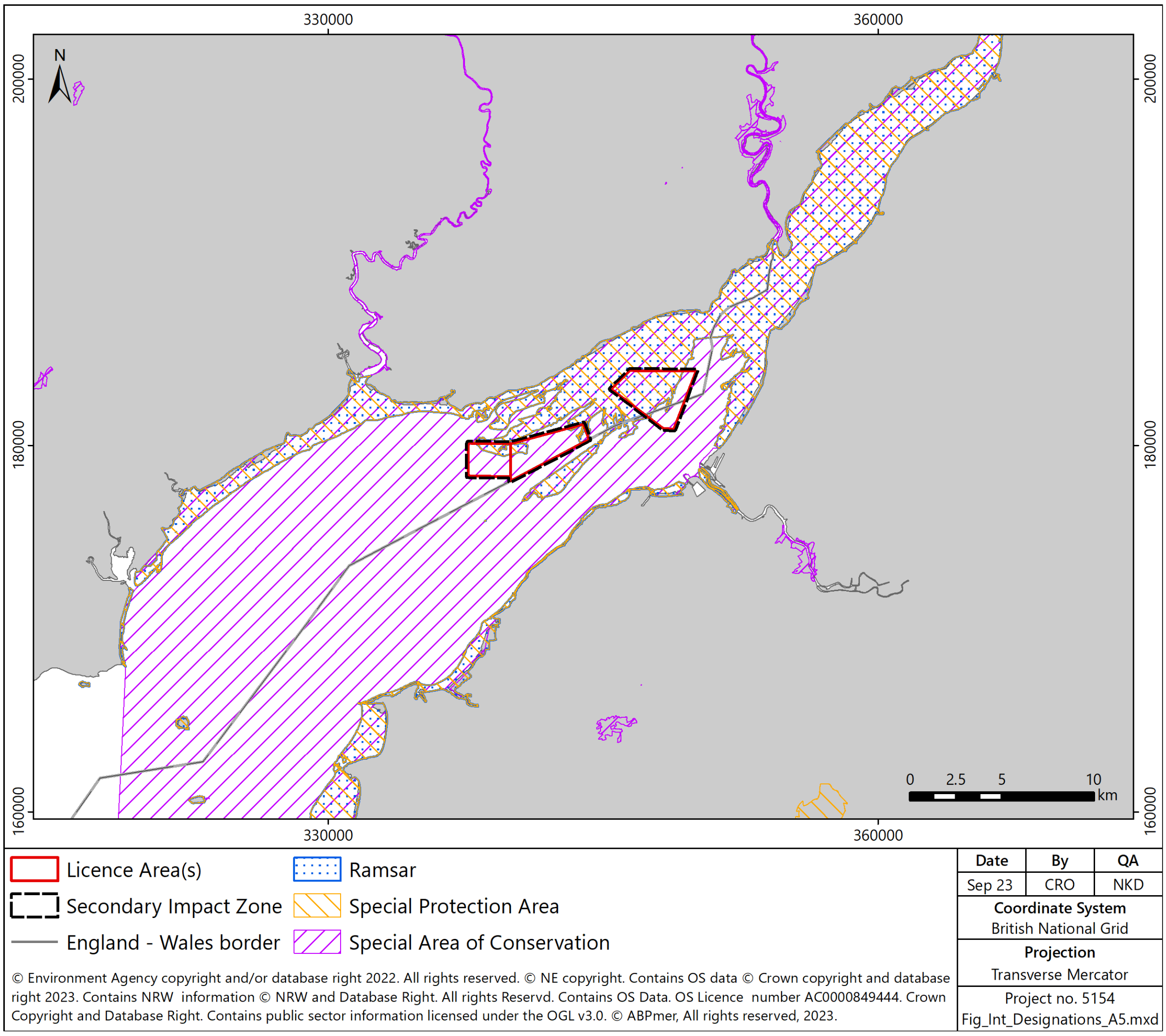

Figure D-2 International designated sites in the vicinity of Bedwyn Sands and NMG

[18] Conservation of Habitats and Species Regulations 2017 (as amended)) still has effect in domestic law under the European Union (Withdrawal) Act 2018, which repealed the European Communities Act 1972 while also maintaining EU-derived domestic legislation in national law. The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 then later made some minor changes to this legislation to accommodate it into UK law.

Three Protected Sites are present within 10 km of the study area. These are the Severn Estuary/Môr Hafren (SAC), the Severn Estuary SPA, and the Severn Estuary/Môr Hafren Ramsar site (Figure D-2). The Renewal Areas directly overlap with all of these Protected Sites.

Bathing Water Directive

The revised Bathing Water Directive (rBWD) (2006/7/EC) was adopted in 2006, updating the microbiological and physico-chemical standards set by the original Bathing Water Directive (BWD) (76/160/EEC) and the process used to measure/monitor water quality at identified bathing waters. The rBWD focused on fewer microbiological indicators, whilst setting higher standards, compared to those of the BWD. Bathing waters under the rBWD are classified as excellent, good, sufficient or poor according to the levels of certain types of bacteria (intestinal enterococci and *Escherichia coli*) in samples obtained during the bathing season (May to September).

The Bathing Water Directive was repealed at the end of 2014 and monitoring of bathing water quality has been reported against revised Bathing Water Directive indicators since 2015. The new classification system considered all samples obtained during the previous four years and, therefore, data has been collected for revised Bathing Water Directive indicators since 2012. The UK Government's target is to achieve 'sufficient' for all bathing waters by 2015, as described under the Bathing Water Regulations 2013[19] (as amended) which transposed the revised Bathing Water Directive into UK law.

There are no designated bathing waters located within 2 km of Bedwyn Sands and NMG. The closest bathing water is Clevedon Beach, approximately 6.8 km to the South of Area 459 within NMG (Figure D-1).

Shellfish Waters Directions

The Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency (in England) and NRW (in Wales) to endeavour to observe a microbial standard in all 'shellfish water protected areas'. The microbial standard is 300 or fewer colony forming units of *E. coli* per 100 ml of shellfish flesh and intravalvular liquid.

The Directions also requires the Environment Agency and NRW to assess compliance against this standard to monitor microbial pollution (75% of samples taken within any period of 12 months below the microbial standard and sampling/analysis in accordance with the Directions).

There are no Shellfish Water Protected Areas located within 2 km of Bedwyn Sands and NMG.

Nitrates Regulations

The Nitrates Directive (91/676/EEC), which was implemented in England by the Nitrate Pollution Prevention Regulations 2015 (as amended), aims to reduce water pollution from agricultural sources and to prevent such pollution occurring in the future (nitrogen is one of the nutrients that can affect plant growth). Under the Nitrates Regulations, surface waters are identified if too much nitrogen has caused a change in plant growth which affects existing plants and animals and the use of the water body.

There are no Nitrate Vulnerable Zones (NVZs) located within 2 km of Bedwyn Sands and NMG.

19 From 31 January 2020, this will be replaced by The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.

Urban Waste Water Treatment Regulations

The Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended) transposed the Urban Waste Water Treatment Directive (91/271/EEC) into English law. These aim to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. The Regulations set treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges. In general, the Urban Waste Water Treatment Regulations require that collected waste water is treated to at least secondary treatment standards for significant discharges. Secondary treatment is a biological treatment process where bacteria are used to break down the biodegradable matter (already much reduced by primary treatment) in waste water. Sensitive areas under the Urban Waste Water Treatment Regulations are water bodies affected by eutrophication due to elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients. There are no "Sensitive Areas (Eutrophic)" as designated under the Urban Waste Water Treatment Regulations located within 2 km of Bedwyn Sands and NMG.

D.2.3 Water and sediment quality

Water quality

Dissolved oxygen

Dissolved oxygen in water is essential for the survival of aquatic organisms (plants and animals) and concentrations provide an indication of the health of a particular waterbody. Therefore, a reduction in dissolved oxygen concentrations, due to an increased biological consumption (e.g. eutrophication) or other natural processes, can dramatically affect the functioning of marine ecosystems. Low dissolved oxygen concentrations have been well documented in several UK estuaries in the past, although investment in wastewater treatment over a number of decades has substantially addressed the issue.

Owens (1984) reported reduced dissolved oxygen saturation in the Upper Severn Estuary (upstream of Bedwyn Sands and NMG), particularly during summer conditions of low flow and high temperature. However, dissolved oxygen concentrations in the Severn Estuary are typically high. In 2004 and 2005, surface water dissolved oxygen concentrations above 8 mg/L were reported throughout the estuary in monitoring samples collected by the Environment Agency (DECC, 2010).

Dissolved oxygen concentrations recorded at the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2019 and 2023 suggest a seasonal trend, with maximum concentration in the winter and minimum concentrations in the summer (high biological oxygen demand; see Table D-2) (Environment Agency, 2023b).

Table D-2 Mean monthly dissolved oxygen concentration (mg/l) from the Environment Agency's 'Severn Estuary EQS monitor off KWR atHW' site between 2019 and 2023

Month and Year	Dissolved Oxygen (mg/l)
September 2019	7.6
October 2019	7.61
November 2019	9.26
December 2019	9.63
February 2020	10.2
March 2020	10.9
May 2021	8.76
May 2023	7.89
June 2023	7.76
August 2023	7.87

There was no apparent trend in oxygen saturation during this period (Table D-3), although values were consistently above 85%. As of 2019, dissolved oxygen in the Severn Lower transitional waterbody was categorised as high with Very Certain confidence (NRW, 2022).

Table D-3 Mean monthly oxygen saturation (%; top) from the Environment Agency's 'Severn Estuary EQS monitor off KWR at high water' site between 2019 and 2023

Month and Year	Oxygen Saturation (%)
September 2019	92.3
October 2019	87.7
November 2019	87.8
December 2019	86.5
February 2020	92.9
March 2020	94.8
May 2021	94
May 2023	87.4
June 2023	96.3
August 2023	96.9

Source: Contains Environment Agency information © Environment Agency and database right

Suspended sediments

The high tidal flows and muddy sediments lead to highly turbid conditions in the estuary (Langston *et al.*, 2003, Manning *et al.,* 2010). Primary sources of material in suspension are from the main tributaries to the estuary - namely the Rivers Severn, Wye, Usk, Avon and Parrett - and from intertidal erosion of mudflats, due to wave action.

The most comprehensive survey of suspended sediment loads across the estuary was undertaken between 1974 and 1978, consisting of multiple cross-estuary transects, which were sampled throughout the tidal cycle. Close to 2,500 profiles were assessed in total. The main findings were of an estuary with high regional turbidity, and a cycling of suspended material over semi-diurnal (ebb and flood) and semi-lunar (spring-neap) timescales, between the water column and the seabed. Sampling indicated an estuary-wide suspended sediment load of around 30 million tonnes on high spring tides, reducing to around 2 million tonnes on low neap tides (Kirby, 1986). Under low-energy conditions, sediments have sufficient time to settle into fluid mud pools in the main estuary channels (e.g. Newport Deep). Primary sinks for suspended material are the sub-tidal areas fronting Bridgwater Bay (in the Inner Bristol Channel) and Newport Deep.

Typically, concentrations in the outer Bristol Channel are <10 mg/l, around 50 mg/l in the inner Bristol Channel and progressively increase into the lower Severn Estuary to >500 mg/l on occasions (Kirby, 1986; 2010). It should be noted that inputs of suspended material to the water column from tidal re-suspension greatly outweigh anthropogenic inputs (DECC, 2010). In the upper reaches of the Severn Estuary, concentrations of suspended particulate matter can be >10 g/l for river flows up to 50 m^3/s, rising to over 50 g/l during periods of lower river flow (Manning *et al.*, 2010).

Based on Environment Agency data, median suspended sediment values along the length of the Severn Estuary range from 81 – 336 mg/l. Within an estuary, the concentration of suspended sediments often develops a maximum where fluxes from rivers and the action of tides and density driven currents converge. This maximum is known as the Estuarine Turbidity Maximum (ETM). For the Severn Estuary, the ETM occurs within the mid estuary region, extending from Sharpness to Watchet (Langston *et al.*, 2003; Kirby *et al.*, 2004; DECC, 2010); a spatial range that incorporates the Middle and Welsh Grounds, NMG, Bedwyn Sands and Area 531.

Suspended sediment concentrations can present discrete variations in vertical, lateral and longitudinal planes within the Severn Estuary (Kirby, 2010). Concentrations can vary markedly in the vertical with extremely high concentrations within near bed layers, often >20,000 mg/l (DECC, 2010). The reduction in flow rate between spring and neap tides leads to an increased settling of suspended sediment, which subsequently becomes re-suspended on the next spring tide cycle (Kirby, 1986; Kirby *et al.*, 2004, DECC, 2010).

Trace metals and organics

Significant improvements in the treatment of substances prior to their release into the marine environment have led to concentrations of metals being typically below EQS values in UK waters. Historical metal smelting in Avonmouth and south Wales led to high cadmium concentrations in the Severn Estuary; however, concentrations have declined between 1995 (0.4 µg/l) and 2001 (0.09 µg/l) to levels below the EQS (Marine Environment Monitoring Group (MEMG), 2004). Elevated concentrations of nickel, mercury, zinc and cadmium were reported at the mouth of the Severn Estuary as part of the Severn Tidal Power study (DECC, 2010), related to increased run-off with proximity to industrial areas. Concentrations of zinc have been reported above EQS values in areas of South Wales (UK Marine Monitoring and Assessment Strategy (UKMMAS), 2010). A summary of trace metal contaminant concentrations in the Severn Estuary reported by Langston and Millward (2008) is shown in Table D-4, including both fresh and saline EQS values for comparison due to the estuarine location of Bedwyn Sands and NMG.

Table D-4 Dissolved and total trace metal concentrations in the Severn Estuary along with WFD (EQS) for fresh and saline waters

Trace Metal (Symbol)	WFD EQS (µg/L) Fresh	WFD EQS (µg/L) Saline	Dissolved Metal Concentration (µg/L)	Total Metal Concentration (µg/L)
Arsenic (As)	50 (AA)	25 (AA)	2.3 ± 0.68	5.75 ± 5.41
Cadmium (Cd)	0.08 – 0.25 (AA), 0.45 – 1.5 (MAC)	0.2 (AA)	<0.25	3.28 ± 8.21
Chromium (Cr)	Cr (III): 0.0047 (AA); 0.032 (MAC); Cr (VI): 3.4 (AA)	Cr (VI): 0.6 (AA), 32 (MAC)	1.09 ± 0.76	16.3 ± 15.7
Copper (Cu)	1 – 28 (AA)	5 (AA)	2.83 ± 1.65	15.8 ± 24.4
Iron (Fe)	1,000 (AA)	1,000 (AA)	492 ± 515	14,173 ± 13,847
Lead (Pb)	7.2 (AA)	7.2 (AA)	5.3	275
Mercury (Hg)	0.05 (AA), 0.07 (MAC)	0.05 (AA), 0.07 (MAC)	0.014 ± 0.108	0.093 ± 0.009
Nickel (Ni)	20 (AA)	20 (AA)	<3	15.5 ± 19.4
Zinc (Zn)	8 – 125 (AA	40 (AA)	6.19 ± 2.9	133 ± 228
AA – Annual Average; MAC – Maximum Allowable Concentration.				

Source: Langston and Millward, 2008; DECC, 2010

Results presented by Jonas and Millward (2010) of dissolved metal concentrations in the Severn Estuary, measured between 2000 and 2005, generally match those shown in Table D-4 (Langston and Millward, 2008). Dissolved arsenic concentrations in low salinity waters peaked at 1.5 µg/l, indicating a potential anthropogenic source of the contaminant, while chromium concentrations were typically <3.5 µg/l. The concentration of dissolved copper was generally <5 µg/l, with the exception of consistent values between 5 and 10 µg/l over two consecutive days of sampling (24-25 August 2005). Zinc concentrations were typically <10 µg/l (Jonas and Millward, 2010).

Contaminant concentrations recorded at four Environment Agency monitoring sites in the vicinity of Bedwyn Sands and NMG between 2013 and 2018 are presented in Table D-5. Concentrations were typically below respective EQS values, although there remained some instances where exceedances have been observed. Since then, chemical status for the Severn Lower transitional water body is currently (2022) moderate as shown in Table D-6. In 2016 when Severn Lower had a chemical status of good, it was recognised that the priority hazardous substance 'brominated diphenylether (BDPE) calc' has not been reported and this parameter was previously (2015) failing to achieve good. In 2022, chemical status was moderate due to the priority hazardous substance 'mercury and its compounds'.

Table D-5 Contaminant concentrations at four Environment Agency monitoring sites in the vicinity of Bedwyn Sands and NMG between 2018 and 2023

Trace Metals	EQS (µg/l)*		Dissolved Concentration (µg/l)			
	Fresh	Saline	1**	2	3	4***
Cadmium	0.08-0.25 (AA); 0.45-1.5 (MAC)	0.2 (AA)	-	0.0326-0.179 ($\bar{x}$ = 0.01; n = 15)	<0.03 – 0.184 ($\bar{x}$ = 0.101 ; n = 25)	-
Copper	1 (AA)	3.76 (AA)	2.28 – 2.44 ($\bar{x}$ = 2.35; n = 3)	2 – 2.6 ($\bar{x}$ = 2.36; n = 5)	-	-
Lead	1.2 (AA); 14 (MAC)	1.3 (AA); 14 (MAC)	-	-	<0.04 – 0.141 ($\bar{x}$ = 0.050; n = 25)	-
Zinc	13.1 (AA)	9.0 (AA)	-	-	-	2.5 – 4.1 ($\bar{x}$ = 3.32; n = 9)

* Based on the WFD Directions 2015
** Data is only available for 2018
*** Data is only available until 2021
AA Annual Average
MAC Maximum Allowable Concentration
1 Oldbury Power Station DS Point
2 Severn Estuary D/S Littleton Upon (EQSD)
3 Severn Estuary EQS Monitor off KWR at High Water
4 Severn Estuary EQS Monitor off Stupp Pill at High Water

Source: Contains Environment Agency information © Environment Agency and database right

Table D-6 Latest 2022 classifications for the Severn Lower transitional waterbody

Trace Metal (symbol)	NRW Cycle 3 Classification
Arsenic (As)	High
Cadmium (Cd)	High
Chromium (Cr)	High
Copper (Cu)	High
Iron (Fe)	High
Lead (Pb)	High
Mercury (Hg)	Moderate
Nickel (Ni)	High
Zinc (Zn)	High
Overall chemical status: moderate	

The concentration of metals in water samples appears to generally reflect the proximity to anthropogenic sources, such as wastewater discharges and industrial settings. Metals which are predominantly of riverine origin tend to decrease in concentration in more saline waters. Conversely, anthropogenic sources of dissolved metals are often observed as the salinity increases downstream (close to the source) before decreasing into the Bristol Channel (Morris, 1984). The concentration of all total metals (including dissolved metals) is highest in the middle reaches of the Severn Estuary, around the location of the Bedwyn Sands and NMG Licence Renewal Areas, which could be associated with trend in suspended solids (DECC, 2010). This is reflected by Nkopuyo and Everard, 2021, in their assessment of heavy metals pollution in soft sediment of the Severn Estuary and Inner Bristol Channel System. They found that Cd, Cr, Ni, Zn and Pb concentrations were higher in the summer than the winter, and the Severn Middle was the most polluted with these elements. For the Severn Middle, it has failed its chemical classification (Environment Agency, 2023a).

Tributyltin (TBT) was used as a biocide in marine antifouling paints for yachts and large ships in the mid-1980s; however, biological effects other than the desired antifouling properties of TBT containing products on marine organisms (e.g. reproductive ability) led to an EU-wide ban on the use of TBT. Historic concentrations of 3 ng/l have been measured in water samples from the Severn Estuary and <4 ng/l in the Bristol Channel (DECC, 2010). TBT was not assessed for the Severn Lower transitional water body as part of the Cycle 1 or Cycle 2 Severn RBMPs (Environment Agency, 2009; Environment Agency and NRW, 2016). It was assessed for Cycle 3, and in this review, it was classed as “high” (NRW, 2023).

Little information is currently available for concentrations of polycyclic aromatic hydrocarbons (PAHs) or polychlorinated biphenyls (PCBs) in water samples. For two locations downstream of Area 531, Law *et al*. (1997) reported concentrations of total PAH in unfiltered water to range between 104 and 164 ng/l at Nash Point and up to 1,150 ng/l adjacent to Port Talbot steelworks (DECC, 2010). As part of the contaminant review of the SEA 8 region, which covers the Western Approaches, Celtic Sea and English Channel, many PAH concentrations exceeded their maximum allowable concentration (MAC) at the mouth of the River Severn (Cefas, 2007).

Measurements of PCBs in mussel tissue (*Mytilus edulis*) and fish liver (plaice, dab, whiting and flounder) were assessed against OSPAR background assessment concentrations (BACs) and environmental assessment criteria (EACs) and reported in Charting Progress 2, suggesting exceedances in EACs within the Severn Estuary. However, PAH concentrations were not considered to represent a major problem to shellfish (UKMMAS, 2010).

Radioactivity

Discharges of radioactive material are strictly controlled and concentrations observed in the UK are reported annually (Radioactivity in Food and the Environment (RIFE) report series). GE Healthcare Limited, the operator of the Cardiff radiopharmaceutical plant, ceased manufacturing a range of radiolabelled products containing tritium (3H) in 2009 and products containing carbon-14 (14C) in 2010. Berkeley and Oldbury nuclear power stations, both of which are currently being decommissioned, are located in the upper reaches of the Severn Estuary, while Hinkley Point B (which ceased operation in 2022) and C are located downstream of Bedwyn Sands and NMG. In 2017, the total dose from all pathways and sources of radiation associated with these facilities was assessed to have been <0.005 mSv (Berkeley and Oldbury) and 0.032 mSv (Hinkley Point), equating to around 3% of the dose limit, with lesser values reported for the Cardiff radiochemical production centre for the same year (<0.005 mSv) (Environment Agency, 2018). The mud in the Bristol Channel has been independently tested by Cefas in 2009, 2013, 2017 and 2020 as commissioned by NRW and Hinkley Point C. In all four cases, the studies concluded that the levels of radioactivity in the mud are so low as a result of Hinkley Point C that they equate to ‘not radioactive’ under UK law (Cefas, 2021).

Sediment quality

There are few formal standards for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority and priority hazardous substances.

Cefas Guideline Action Levels have been prepared to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between AL1 and AL2 requires further consideration and testing before a decision can be made. The Cefas Guideline Action Levels should not be viewed as pass/fail thresholds. Furthermore, it should be noted that the Bedwyn Sands Licence Renewal does not consider the disposal of material at sea; however, these guidelines provide an appropriate context for consideration of contaminant levels in sediments.

Environment Agency monitoring data of sediments in the Severn Estuary was collected between 2007 and 2011, including the following two sites located close to the mouth of the River Avon (2.5 km from the Bedwyn Sands Licence Renewal Area):

- Severn Estuary off Holesmouth at High Water; and
- Severn Estuary off KWR at High Water.

Table D-7 Cadmium and mercury sediment concentration from KWR and Holesmouth Environmental Agency monitoring stations

Metal	Cefas Guideline Action Level (mg/kg dw)		Year	Sediment Concentration (mg/kg dw)	
	AL1	AL2		Holesmouth	KWR
Cadmium	0.4	5	2007	<0.1	2.27
			2008	0.423	0.382
			2009	0.837	0.599
			2010	-	0.831
			2011	-	0.901
Mercury	0.3	3	2007	0.3	0.31
			2008	0.265	0.245
			2009	0.27	0.259
			2010	-	0.296
			2011	-	0.319

Source: Contains Environment Agency information © Environment Agency and database right

Table D-7 presents cadmium and mercury sediment concentration from the two nearby monitoring sites. Sediment concentration for cadmium and mercury was less than AL2 for all samples collected, with many concentrations less than AL1 (particularly for mercury). It should be noted that the sediment type may be different between these two monitoring stations and the Bedwyn Sands and NMG Licence Renewal Areas. The sediment type at Bedwyn Sands and NMG is dominated by sandy material and will thus have lower contaminant concentrations than muddy area.

Sediment concentration for various metals has also been measured by the Environment Agency at several monitoring sites further downstream (Bristol Channel), including the following:

- Severn Estuary adjacent to Weston-Super-Mare Black Rock O/F;
- Bridgwater Bay; and
- Bristol Channel Inner South Sediment WFD-BI.

Table D-8 presents the maximum sediment concentration of metals measured from the three downstream monitoring sites. As with the two monitoring sites in close proximity to the Bedwyn Sands Licence Renewal Area, there were no metal concentrations in sediments which exceeded AL2 (although fewer samples were less than AL1).

Table D-8 Maximum metal sediment concentration from Adjacent Western-Super-Mare, Bridgwater Bay and Bristol Channel Inner Environmental Agency monitoring stations

Metal	Cefas Action Level (mg/kg dw)		Year	Sediment Concentration (mg/kg)		
	AL1	AL2		Adjacent to Western-Super-Mare Black Rock O/F	Bridgwater Bay	Bristol Channel Inner South Sediment WFD-BI
Arsenic	20	100	2011	-	-	22.1
			2012	-	24	-
			2013	-	-	14.7
			2015	-	19.2	-
Cadmium	0.4	5	2008	0.225	-	-
			2009	0.452	-	-
			2010	0.653	-	-
			2011	0.751	-	0.618
			2012	-	0.194	-
			2013	-	-	0.144
			2015	-	0.246	-
Chromium	40	400	2011	-	-	89.2
			2012	-	115	-
			2013	-	-	94.8
			2015	-	93.7	-
Copper	40	400	2011	-	-	61.3
			2012	-	43	-
			2013	-	-	32.7
			2015	-	31.4	-
Lead	50	500	2011	-	-	111
			2012	-	77.7	-
			2013	-	-	108
			2015	-	63.1	-
Mercury	0.3	3	2008	0.196	-	-
			2009	0.226	-	-
			2010	0.203	-	-
			2011	0.22	-	0.317
			2012	-	0.305	-
			2013	-	-	0.183
			2015	-	0.270	-
Nickel	20	200	2011	-	-	40.3
			2012	-	58.1	-
			2013	-	-	41.2
			2015	-	38.2	-

Metal	Cefas Action Level (mg/kg dw)		Year	Sediment Concentration (mg/kg)		
	AL1	AL2		Adjacent to Western-Super-Mare Black Rock O/F	Bridgwater Bay	Bristol Channel Inner South Sediment WFD-BI
Zinc	130	800	2011	-	-	268
			2012	-	245	-
			2013	-	-	196
			2015	-	218	-

According to Langston *et al.* (2003), trace metal concentrations in the sediments of the Severn Estuary and Bristol Channel are relatively uniform, reflecting the strong tidal mixing and fluid mud transport which disperse contaminants from their source. Duquesne *et al.* (2006) reported that sediment metal concentrations in the Severn Estuary and Bristol Channel were highest at sites close to industrial centres but levels have decreased significantly over the last 30 years. Metal concentrations (mg/kg dry weight) ranged from 0.1 – 1.4 for cadmium, 10 – 90 for chromium, 1 – 47 for copper, 4 – 45 for nickel, 5 – 92 for lead and 20 – 340 for zinc. The authors indicate that the highest metal concentrations in deposited sediments were typically associated with the finest particulates at locations with muddy sediments, although acknowledges that this was not always the case at sites with predominantly sandy sediments. Nevertheless, the values reported by Duquesne *et al*. (2006) are in line with those reported by the Environment Agency.

As part of a review of contaminant status of the SEA 8 region (Cefas, 2007), sediment samples from the Severn Estuary and Bristol Channel were analysed. Once normalised to aluminium concentration to highlight anthropogenic inputs (as opposed to granulometric and mineralogical differences), elevated concentrations of nickel, cadmium, mercury and zinc were found at the mouth of the Severn Estuary and were attributed to increased run-off in proximity to industrial areas (e.g. Bristol, Cardiff, Swansea) (Cefas, 2007).

In addition, the highest concentrations of PAHs in the SEA 8 region were found at two stations at the mouth of the River Severn (3,301 and 3,188 µg/kg dry weight). The highest total PCB concentration was also measured near the mouth of the River Severn (32.59 µg/kg dry weight) (Cefas, 2007). Concentrations of contaminants such as PAHs and PCBs contained in fine sediments such as muds and silts are higher than those measured in the water column due to adsorption of contaminants to sediment particles (MEMG, 2004). This is particularly true of the less soluble substances such as metals and many organic substances which tend to attach to suspended and deposited sediments. High levels of organic contamination are generally not associated with coarse sediments (MEMG, 2004), such as the sands and gravels targeted during aggregate dredging activities. The highest concentration of TBT in the sediments sampled between 1992 and 1997 from the Severn Estuary (around Swansea) was 2.37 µg/g wet weight (Cefas, 2000), with concentrations in the higher ranges occurring in the vicinity of the ports of Newport, Cardiff and Swansea (DECC, 2010).

D.3 Scoping

The "Clearing the Waters for All" guidance (Environment Agency, 2016) provides a scoping template to record findings and consider potential risks for several key receptors, including:

- Hydromorphology;
- Biology: Habitats and Fish;
- Water quality;
- Protected areas; and
- Invasive non-native species (INNS).

Each receptor is considered in the following sections and summarised in a table. Potential risks that have been scoped into the assessment are highlighted in red and considered within the detailed assessment stage (Section D.4), while those scoped out of the assessment are highlighted in green.

D.3.1 Hydromorphology

Hydromorphology is the physical characteristics of estuaries and coasts, including the size, shape and structure of the water body and the flow and quantity of water and sediment. Table D-9 presents a summary of hydromorphological considerations and associated risk issues for aggregate extraction within Bedwyn Sands and NMG. As at least one hydromorphological consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-9 Hydromorphology scoping summary

Hydromorphology Considerations	Hydromorphology Risk Issue(s)
Consider if your activity could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status?	No (hydromorphology not at high status). Impact assessment not required.
Consider if your activity could significantly impact the hydromorphology of any water body?	Yes (potential changes to hydromorphology because of activity, e.g. changes to flow rates). Requires impact assessment.
Consider if your activity is in a water body that is heavily modified for the same use as your activity?	No (hydromorphological designation related to flood protection). Impact assessment not required.

D.3.2 Biology

It is necessary to consider the impact of the physical footprint of an activity on nearby marine and coastal habitats. This specifically refers to habitats of higher sensitivity (e.g. intertidal seagrass, maerl and saltmarsh) and lower sensitivity (e.g. cobbles, gravel and shingle, subtidal rock reef and intertidal soft sediments like sand and mud). Table D-10 presents a summary of biology (habitat) considerations and associated risk issues for the aggregate extraction within Bedwyn Sands and NMG. As at least one biology (habitat) consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-10 Biology (habitat) scoping summary

Biology (Habitat) Considerations	Biology (Habitat) Risk Issue(s)
Is the footprint of the activity 0.5 km^2 or larger?	Yes, footprint of activity is 9.4 km^2 and 10.4 km^2. respectively. Impact assessment required.
Is the footprint of the activity 1% or more of the water body's area?	No (<1%). Impact assessment not required.
Is the footprint of the activity within 500 m of any higher sensitivity habitat?	No (>500 m). Impact assessment not required.
Is the footprint of the activity 1% or more of any lower sensitivity habitat?	Yes (>1% intertidal/subtidal soft sediment). Impact assessment required.

Fish

Activities occurring within an estuary could impact on normal fish behaviour such as movement, migration or spawning. Table D-11 presents a summary of biology (fish) considerations and associated risk issues for the Proposed Development. As at least one biology (fish) consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-11 Biology (fish) scoping summary

Biology (Fish) Considerations	Biology (Fish) Risk Issue(s)
Consider if your activity is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary?	Yes. "Continue with questions".
Consider if your activity could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)?	Yes. Requires impact assessment.
Consider if your activity could cause entrainment or impingement of fish?	Yes. Requires impact assessment.

D.3.3 Water Quality

Consideration should be made regarding whether phytoplankton status and harmful algae could be affected by the proposed works, as well as identifying the potential risks of using, releasing or disturbing chemicals. Table D-12 presents a summary of water quality considerations and associated risk issues of aggregate extraction within Bedwyn Sands and NMG. As at least one water quality consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-12 Water quality (physical parameters) scoping summary

Water Quality Considerations	Water Quality Risk Issue(s)
Consider if your activity could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)?	No. Any change to water clarity and oxygen levels will occur within a spring neap tidal cycle and is expected to be insignificant. Impact assessment not required.
Consider if your activity is in a water body with a phytoplankton status of moderate, poor or bad?	No (phytoplankton status assessed as high). Impact assessment not required.
Consider if your activity is in a water body with a history of harmful algae?	No (evidence for harmful algae not monitored). Impact assessment not required.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if the chemicals are on the Environmental Quality Standards Directive (EQSD) list?	No (not applicable). Impact assessment not required.

Water Quality Considerations	Water Quality Risk Issue(s)
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if it disturbs sediment with contaminants above Cefas Action Level 1?	Yes (potential for sediment-bound contaminants to be disturbed). Impact assessment required.
If your activity has a mixing zone (like a discharge pipeline or outfall) consider if the chemicals released are on the EQSD list?	No (not applicable). Impact assessment not required.

D.3.4 Protected areas

Consideration should be made regarding whether WFD protected areas are at risk from your activity, including SACs and SPAs (Natura 2000 sites), as well as bathing waters, shellfish waters and nutrient sensitive areas. Table D-13 presents a summary of protected area considerations and associated risk issues of aggregate extraction within Bedwyn Sands and NMG. As the protected areas consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-13 Protected areas scoping summary

Protected Area Considerations	Protected Area Risk Issue(s)
Consider if your activity is within 2 km of any WFD protected area?	Yes (protected areas within 2 km). Impact assessment required.

D.3.5 Invasive non-native species (INNS)

Consideration should be made regarding whether there is a risk the activity could introduce or spread INNS. Risks of introducing or spreading INNS include materials or equipment that have come from, had use in or travelled through other water bodies, as well as activities that help spread existing INNS, either within the immediate water body or other water bodies. Table D-14 presents a summary of INNS considerations and associated risk issues of aggregate extraction within Bedwyn Sands and NMG. As the INNS consideration indicates that a risk could be associated with aggregate extraction within Bedwyn Sands and NMG, this receptor has been scoped into the detailed assessment (see Section D.4).

Table D-14 Invasive non-native species scoping summary

INNS Considerations	INNS Risk Issue(s)
Consider if your activity could introduce or spread INNS?	Yes (potential for introduction or spread of INNS). Requires impact assessment.

D.4 Detailed Assessment

A detailed assessment should be conducted for each receptor identified during the scoping stage as being at risk from an activity. As highlighted in Section D.3, the following receptors have been scoped into the detailed assessment:

- Hydromorphology;
- Biology: Habitats and Fish;
- Protected species; and
- Invasive non-native species (INNS).

Each of these WFD parameters have been evaluated to determine whether aggregate extraction within Bedwyn Sands and NMG might cause deterioration in the status of the relevant water body (defined as a non-temporary effect on status at water body level), or an effect that prevents the water body from meeting its WFD objectives. Where possible, the assessment has drawn on information presented in the ES (see main report).

D.4.1 Hydromorphology

The Severn Estuary is subject to a strongly semi-diurnal and very large tide with a range of 10 to 12 m, giving the estuary the second largest tidal range in the world. This high tidal range is due to the combination of the North Atlantic tidal wave approaching through the Bristol Channel and the further amplification and convergence of this tidal wave as it moves into the funnel-shape of the Severn Estuary. The tidal prism[20] of the Severn Estuary has been calculated at approximately 96 x 10^8 m^3 (Atkins, 2009).

The tide enters the Severn Estuary from the Bristol Channel as a progressive tidal wave. As the tide moves upstream it amplifies in range, reaching a mean spring tidal range of 12.2 m at Avonmouth and a maximum of 12.3 m, on mean spring tides, at Beachley (Chepstow, Severn Bridge). Further upstream, the estuary widens out slightly and shallows rapidly, leading to increased asymmetry of the shape of the tidal curve and, therefore, steepening of the curve due to the shallow water effects. In this way, the interaction of the tidal wave with the shallowing bed causes a slowing of the trough of the tidal wave, with respect to the crest, therefore creating asymmetry.

The large and rapid rise and fall of the tide leads to very strong currents through the main body of the estuary. These strong currents maintain deep channels and high suspended sediment loads. Flows also increase in strength where they are forced through constrained narrows (e.g. The Shoots, just below the Second Severn Crossing, where the currents can exceed 6 m/s).

Where the tide becomes asymmetric, then dominance is established between ebb and flood currents; this effect also increases further up the estuary. Tidal currents appear to be the primary mechanism for sorting seabed materials, so that the channels tend to contain gravels, with rocky patches, and the intertidal margins of the estuary have muddy deposits. Within the centre of the estuary, there is also a large sand body contained within the Middle Grounds, which extends to the northeast into Welsh Grounds. The direction of the currents is strongly influenced by the morphology of the seabed, with currents generally aligned through the main channels and past shallow sandbanks. However, geological hard points extend out into the estuary and can influence the tidal flows to produce local modifications to the flow regime.

Marine sands are pushed up the estuary during the fast-flowing flood tide, where they are deposited during slack water. The slower flowing ebb tide is generally unable to remobilise all the material for a seaward return and, therefore, sand is transported up the estuary by a process called ‘tidal pumping’. Muds appear to remain in suspension for most tides and tend to be introduced into the estuary primarily from fluvial sources.

As previously noted, the Severn Estuary is a relatively high suspended sediment environment. Primary sources of material in suspension are from the main tributaries to the estuary, namely the Rivers Severn, Wye, Usk, Avon and Parrett, and from intertidal erosion of mudflats, due to wave action. The most comprehensive survey of suspended sediment loads across the estuary was undertaken between 1974 and 1978, consisting of multiple cross-estuary transects, which were sampled throughout the tidal cycle. Close to 2,500 profiles were assessed in total. The main findings were of an estuary with high regional

20 i.e. the volume of water the enters and leaves the estuary on an average tide, calculated as the difference between the tidal volume at high water and that at low water.

turbidity, and a cycling of suspended material over semi-diurnal (ebb and flood) and semi-lunar (spring-neap) timescales, between the water column and the seabed. Sampling indicated an estuary-wide suspended sediment load of around 30 million tonnes on high spring tides, reducing to around 2 million tonnes on low neap tides (when sediments have sufficient time to settle into fluid mud pools in the main estuary channels, e.g. Newport Deep).

Dredging activity results in a lowering of the bed over the extraction area. Where this dredge is relatively deep, or where recovery times are long, such bed lowering has the potential to affect tidal currents over the site. The coastal impact study (ABPmer, 2023) predicted relatively small changes to flood and ebb tidal currents which are principally confined to within 3 km of the extraction area boundaries. Across the study area, the predicted magnitude of change is largely less than ±0.05 m/s (<6% of baseline flows) in peak current speed and less than 2° shift in current direction. No change is predicted to the existing (baseline) tidal asymmetry, following the proposed extraction of the renewal volumes.

The predicted changes to the extreme wave heights (1:200 year) are also small in magnitude and although they extend slightly beyond the boundaries of the licence areas (notably under MLWS conditions), they do not impact either the English or Welsh coastlines under any of the wave conditions assessed. The magnitude and extent of predicted effect is greatest for waves approaching from the southwest and coinciding with MHWN. Extraction is predicted to generate increased wave heights of up to 0.14 m (~6% baseline) in NMG and of up to 0.05 m (1-2% baseline) in Bedwyn Sands. Changes in direction of less than 2° are predicted for waves approaching from the southwest. Predicted changes to the wave regime from the range of other directions assessed within the CIS are lower in magnitude and smaller in extent. Under MLWS conditions, the predicted effects on wave conditions are greatly limited in extent by the drying intertidal sandbanks. The predicted effects on a more typical (10 in 1-year) wave, under both MHWS and MLWS elevations, are reduced in extent and magnitude compared to the extreme wave event assessments.

Predicted changes to current speeds and wave heights, as a result of the conservative extraction scenario assessed, are generally constrained to within the extraction areas and are of small magnitude in both relative and absolute terms. Given the dynamic nature of the Severn Estuary, it is considered that the changes predicted would not be measurable within the range of natural variability. On this basis, it is concluded that there is no risk from the predicted changes to the tidal current speed/direction, 1:200-year wave height, or from energy focussing along sensitive coastlines. As a result, the magnitude of change and probability of occurrence at the coastline are both assessed as negligible, and the associated impact is assessed as insignificant. The extreme wave is also an infrequent event that is unlikely to affect the net long-term transport pathways. As a result, it is considered that both littoral transport (along the English and Welsh coasts), and sand transport within, and upstream of, the Middle and Welsh Grounds, would not be affected by the proposed renewal of the ongoing extraction activity.

In conclusion, aggregate extraction within Bedwyn Sands and NMG is not expected to lead to a deterioration of the assessed hydromorphological elements within the Severn Lower transitional water body, nor prevent the water body from meeting its WFD objectives.

D.4.2 Biology

Habitats

The Severn Estuary provides a wide variety of intertidal habitats including mudflat, sandflat, gravel and rocky shore. Large-scale biotope mapping surveys have identified the spatial extent of intertidal habitats within the Severn Estuary. The Countryside Council for Wales (CCW; now NRW) surveyed the Welsh shore of Severn Estuary as part of a wider Phase 1 intertidal habitat mapping survey of the entire Welsh coast between 1996 and 2004 (Brazier *et al.,* 2007). Natural England subsequently commissioned a survey of the English side of the Severn Estuary which was undertaken between 2003 and 2004 (Emu, 2006). Most of these habitats, or sub-categories thereof, are considered Habitats of Principal Importance under the 2006 NERC Act (England), as well as the Environment (Wales) Act 2016. This includes saltmarshes and mudflats, as well as coastal sand dunes, vegetated shingle, maritime cliffs and slopes, rocky habitats and intertidal boulders.

Subtidal benthic communities of the Severn Estuary are generally impoverished due to seabed scouring and mobility of sediments that result from its large tidal range (Mettam *et al.,* 1994; Warwick and Somerfield, 2010; Ecospan Environmental Ltd. 2013). In the Severn Estuary, subtidal habitats have different sedimentary compositions, including muddy sands, clean sands, rock and gravely areas (Langston *et al.,* 2003). However, the predominant unconsolidated sediments are muds and sands, the relative composition of which varies throughout the estuary. Each of these sediment types, and the differing physical processes in operation, support a different invertebrate assemblage (Warwick and Davies, 1977; Warwick and Uncles, 1980; Mettam *et al.,* 1989).

The main impact of marine aggregate extraction relates to the direct removal of seabed sand and gravel; this removes benthic species and habitats that live on or within the sediment extracted. Previous research has suggested that this can result in a 40 to 95% reduction in the number and biomass of organisms, and a 30 to 70 % reduction in the number of species present (Newell *et al.,* 1998). Seabed removal can therefore result in a change to benthic biotopes and their associated fauna and can impact prey/food items available to higher trophic organisms (Moulaert *et al.,* 2005). Removal of organisms however is restricted to areas where dredging occurs, and the higher the dredging intensity is, the more pronounced the impact (Boyd and Rees, 2003). Individuals entrained are not necessarily killed. Some may survive the entrainment process and be returned to the sea in outwash or during screening. The proportion of individuals that escape, and their subsequent survival rate, is not known (Tillin *et al.,* 2011). Additionally, some mobile epifauna may have the ability to avoid entrainment by moving away from the head.

The recoverability of benthic resources following the cessation of dredging is influenced by several environmental factors including sediment type and hydrodynamics (e.g. Foden *et al.,* 2009). Generally, recovery occurs faster in unstable dynamic environments such as shallow water mobile sands where typical recovery times range from a few months to two to four years. Conversely, for stable environments, such as deep water stable gravels, recovery can take up to 15 years due to the presence of long lived species (Tillin *et al.,* 2011). A disturbed site may not re-colonise in accordance with 'baseline' communities (e.g. Barrio Froján *et al.,* 2011; Tillin *et al.,* 2011). Rates of recolonisation and recovery of benthic communities generally conform to the well-known principles of ecological succession. Sites are initially colonised by short-lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly polychaetes worms. In time, these are succeeded by longer-lived, slower growing species with a lower tolerance for disturbance (Newell *et al.,* 1998; Hill *et al.,* 2011; Barrio Froján *et al.,* 2011). However, in dynamic environments, opportunistic species are often dominant in un-dredged areas (e.g. Cooper *et al.,* 2007), reflecting the prevailing regime of ongoing natural disturbance.

Regarding significance of impact on benthic habitats and species, Bedwyn Sands and NMG is mainly characterised by highly impoverished mobile clean sand with almost no benthic fauna recorded (Emu, 2001; Ecospan Environmental, 2013). The species poor, macrofaunal community present consists of species typical of tide swept sandflat habitat. These species are well adapted to living in a dynamic and disturbed tide swept environment. These disturbance-tolerant species also are considered to have high recoverability rates and are capable of rapidly recolonising disturbed habitat (Budd, 2006; Budd and Curtis 2007; Budd and Hughes, 2005). No eelgrass beds or other protected species or species/biotopes considered nationally rare or important have been recorded within Bedwyn Sands and NMG.

Dredging activities result in the suspension of disturbed sediment and subsequent deposition of material (mostly by screening, overspill and hopper washing) (Newell *et al.,* 1998). This can lead to changes in sediment availability for subtidal and intertidal habitats and species. These changes may alter the composition of the biological assemblage associated with this receptor and may result in positive and negative impacts, the degree and type of which is likely to vary with distance from the extraction site. Increased siltation may lead to the gills of suspension feeders (grazing on suspended organic matter i.e. bivalves) becoming clogged and favour the development of deposit feeders (that graze on settling organic matter i.e. polychaetes). However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions, reducing their sensitivity to the impact. The negative effects of increased suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects. However, this is generally thought to be of less concern where fauna are adapted to naturally high levels of suspended sediments (Boyd *et al.,* 2004).

Increases in SSC have the potential to disturb, or even kill benthic species, altering the benthic community structure of the area. The predicted increases in SSC will only occur during dredging operations and for several hours after the cessation of dredging. Even when these temporary concentration increases occur, they will be of a similar magnitude to those which occur naturally as a result of variation in tidal condition and waves. The sediment plumes will be generated mainly from overspill and screening and are expected to be localised. Thus, in physical terms, the plumes resulting from proposed dredging will have a minimal effect on SSC. The biotopes and species identified in the vicinity of Bedwyn Sands and NMG are considered to be typical of the Severn Estuary and wider Bristol Channel region, being well adapted to turbid conditions as a result of natural sediment mobility in and around the study area.

Higher sensitivity habitats observed within the renewal licence areas include:

- LS.LSa.FiSa.Po 'Polychaetes in littoral fine sand'
- LS.LSa.MoSa.AmSco 'Amphipods and *Scolelepis* spp. in littoral medium-fine sand'
- LS.LSa.MoSa.BarSa: 'Barren littoral coarse sand'
- LS.LMu.MEst.HedMac: '*H.diversicolor* and *M. balthica* in littoral sandy mud'
- LS.LSa.MoSa.AmSco.Eur: '*E. pulchra* in littoral mobile sand'

Despite habitats such as polychaete reefs being are sensitive to direct removal and potential smothering during aggregate extraction; proposed dredging activity within Bedwyn Sands and NMG is not expected to remove any reefs nor increase SSCs above the already high levels recorded in the Severn Estuary.

The fauna associated with the material that is to be removed by the dredging process may be injured or killed, and habitats could theoretically be lost, albeit acknowledging that all the habitats present within the Renewal Areas are widespread in the estuary. Furthermore, the natural changes experienced on these areas as a result of coastal processes and sediment transport, means these habitats have been historically and regularly impacted by the natural environment.

In conclusion, aggregate extraction within Bedwyn Sands and NMG are not expected to lead to a deterioration of the assessed habitats within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

Fish

The fish community of the Severn Estuary is notably species rich and exceeds 100 species in total. The use of conventional fish sampling techniques in the Severn Estuary is difficult because of the large expanses of inaccessible intertidal areas and the macro-tidal conditions. Most of the available knowledge of the Severn Estuary fish community comes from the individuals entrained on the cooling water intake screens used at power stations situated along the English and Welsh shores. Fish and crustacean abundance at Hinkley Point power station situated at the seaward margin of the estuary in Bridgewater Bay were monitored between 1980 and (Henderson and Bird, 2010). Similar records are available from Oldbury power station in the Upper Severn Estuary from 1972 to 1977 and 1996 to 1999 (Henderson and Bird, 2010; Bird, 2008). The Severn Estuary is used by a variety of migratory fish species, including twaite shad, river lamprey and sea lamprey, which are all Annex II qualifying species for the Severn Estuary SAC.

The main impact pathway in which fish may be affected by aggregate extraction within Bedwyn Sands and NMG is from elevated underwater noise levels during operation. Elevated noise and vibration levels caused by the action of the dredger could potentially disturb fish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.,* 2015). Noise impacts on fish are restricted to behavioural changes through avoidance, which are limited to a localised area around the dredger for most species. As the dredger vessel is moving, fish are not physically constrained; they will be able to move away from the source of the noise and return once dredging activity has ceased.

The changes in water quality and the temporary deposition of disturbed sediment during overspilling and screening activities could also potentially impact on fish. The predicted increases in SSCs will only occur during dredging operations and for several hours after the cessation of dredging. Even when these temporary concentration increases occur, they will be of a similar magnitude to those which occur naturally as a result of variation in tidal conditions and waves, particularly given the naturally high background turbidity levels experienced in the Severn Estuary. Furthermore, the worst case footprints of the plume are localised.

Overall, aggregate extraction within Bedwyn Sands and NMG is not expected to lead to a deterioration of fish within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

D.4.3 Water quality

With specific reference to the activity within the Bedwyn and NMG sites, aggregate extraction activity is limited to a period a few hours either side of high water, due to the otherwise shallow nature of the extraction sites. This means that water depths across the extraction site, and the wider region, are generally small and means that any material in put into suspension by the extraction activity will not have far to settle out. This shallow water depth, along with the relatively coarse nature of the bed material and the relatively slack water conditions around high water, means that any material will settle quickly to the bed and any associated dispersion across the wider study area will be severely limited. The values described above (from the HRW Wallingford, 2010 study) are, therefore, considered to provide an upper-limit worst case for changes to suspended sediment concentrations with actual magnitudes and extents of effect being considerably lower. Therefore, in the context of the extraction activity and the Severn Estuary's natural suspended sediment regime (as outlined in Section 6.2 of the ES), for which high SSCs are common, any potential increases in SSC are expected to be negligible.

Several reviews of inputs of contaminants into the Severn Estuary have been undertaken over the past three decades. Rivers are the primary source of metals (copper, iron, nickel, mercury, cadmium, lead and zinc), dissolved organic carbon, silicate, suspended solids and phosphate. Urban and industrial wastewater discharges and atmospheric deposition are also sources of pollutants. Pollutants are more effectively adsorbed by fine-grained sediments (clay, mud and silt), which usually contain high concentrations of organic matter, than by coarser particles. The finer particles are also more likely to be re-suspended by currents and transported to regions far from their point of origin. For these reasons, silty muds usually contain the highest concentrations of contaminants. It should be noted that the target sediment type at Bedwyn Sands and NMG is sand/gravel material and this is likely to have low contaminant concentrations.

The Severn Lower transitional water body is currently (2021) classed as 'moderate', based on 'moderate' ecological potential and 'moderate' chemical status (NRW, 2022). Aggregate extraction from Bedwyn Sands and NMG is unlikely to lead to a deterioration of chemical parameters within the Severn Lower transitional water body, nor prevent this water body from meeting its WFD objectives.

D.4.4 Protected areas

Bedwyn Sands and NMG overlap with three Protected Sites which are present within 10 km of the study area. These are the Severn Estuary/Môr Hafren (SAC), the Severn Estuary SPA, and the Severn Estuary/Môr Hafren Ramsar site. The Renewal Areas directly overlap with all of these Protected Sites. The habitats within these sites support important numbers of resident and migratory birds and marine species. Together, these sites form the Severn Estuary/Môr Hafren European Marine Site which protects the following features:

- Estuaries;
- Intertidal mud and sandflats (not covered by seawater at low tide);
- Sandbanks which are slightly covered by sea water at all times;
- Saltmarsh;
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae)*
- Reefs;
- Subtidal sandbanks;
- Migratory fish (including Sea lamprey (*Petromyzon marinus*); River lamprey (*Lampetra fluviatilis*); and Twaite shad (*Alosa fallax*)) ; and
- Birds (overwintering and on passage).

In considering the potential effects of the proposed dredging on the key features of these designated sites, the Appropriate Assessment Signposting Document (Appendix C) suggests that dredging within Bedwyn Sands and NMG is not anticipated to affect the integrity of any of the European/Ramsar Sites, as no failure of the conservation objectives (alone or in-combination) is predicted. Therefore, aggregate extraction within NMG is not expected to lead to a deterioration of the assessed protected area designations, nor prevent the water body from meeting its WFD objectives.

D.4.5 Invasive non-native species

As with most activities which occur in the marine environment, there is potential risk that aggregate extraction within Bedwyn Sands and NMG could result in the introduction or spread of INNS. For example, this could include the movement of vessels from differing water bodies, the use (release) of ballast or the transfer of organisms attached to vessel hulls.

Consideration of INNS is now standard practice during operations at marine aggregate production licence areas through the use of the Biosecurity Plan Template and Guidance Document (ABPmer, 2018a; 2018b) and the INNS reporting protocol.

For the Renewal Areas, the risk of INNS introduction is small. .This is because the dredging vessel(s) will be restricted to inshore movements between the Renewal Areas and unloading areas (primarily at Newport but also Chepstow and Avonmouth). The increased risk of the spread of INNS from one unloading port to another and from between the unloading areas and the Renewal Areas is small given that the INNS identified are widespread throughout the Severn Estuary. Localised movements of boats in the coastal zone are considered to have a much lower risk of introducing and spreading non-native species than large, ocean going vessels which travel large distances.

Consequently, the probability of the introduction and spread of INNS from dredging is considered low and it is not expected to lead to a deterioration in status of the water body, nor prevent the water body from meeting its WFD objectives.

D.5 Conclusion

Based upon the information presented within this WFD compliance assessment, and considering the additional information presented in the ES (see main report), it is concluded that aggregate extraction within Bedwyn Sands and NMG is not likely to have a permanent (i.e. non-temporary) effect on the status of WFD parameters that are significant at water body level. Therefore, deterioration to the status of the Severn Lower transitional water body is not predicted, nor a prevention of this water body achieving future WFD status objectives.

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E Marine Plan Conformance Assessment

E.1 Introduction

A combined marine plan conformance assessment (this appendix) has been prepared in support of the Marine Licence application for the dredging of marine aggregates from Bedwyn Sands and North Middle Ground (NMG) (Areas 455 and 459). The purpose of this document is to set out the marine planning context applicable to the proposed activity and identify those policy considerations that will be material to the decision-making process.

A marine planning conformity document has been produced to ensure that the marine licensing authorities, the Marine Management Organisation (MMO) and Natural Resources Wales (NRW), are provided with a holistic analysis of the acceptability of the proposed activity in policy terms and of how it contributes towards the achievement of specific policies.

The dredging of marine aggregates from Bedwyn Sands and NMG has been subject to formal Environmental Impact Assessment (EIA), the outcomes of which have been reported in the Environmental Statement (ES) (see Sections 1 to 21 of the main report). In addition, a number of environmental assessments have been undertaken in support of the marine licence application, including a Habitats Regulations Assessment (HRA) (Appendix C) and a Water Framework Directive (WFD) Compliance Assessment (Appendix D).

The outcomes of these environment assessments have informed the content of this combined marine plan conformance assessment, specifically in relation to assisting the determination of compliance between the project and the overarching planning framework in England and Wales.

E.2 Marine Planning

The Marine and Coastal Access Act (MCAA) 2009 provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment. The MCAA also established the MMO, the authority tasked with ensuring the delivery of sustainable development in the marine area.

E.2.1 Marine Policy Statement

The Marine Policy Statement (MPS) adopted by all UK administrations in March 2011, provides the policy framework for the preparation of marine plans, establishing how decisions affecting the marine area should be made in order to enable sustainable development. The MPS also provides an overview and summary of national policy relevant to marine planning and decision-making in the marine area. Marine plans are intended to guide developments and activities, to ensure maximisation of the economic worth of the marine area in a sustainable way.

The MPS considers marine aggregates to present reduced impacts on local communities compared to the extraction of land-won aggregates, in particular with regard to the extraction process and transportation. The MPS states that a marine licence or other regulatory approval to dredge should only be issued if the decision maker is content that the proposed dredging is environmentally acceptable. Potential adverse impacts are listed to include changes to the hydrodynamic regime that may alter coastal processes; loss of seabed habitat and heritage assets; impacts on fisheries and secondary impacts to marine life and habitat associated with sediment plumes; disturbance of fish spawning, migration routes, nursery and overwintering areas; overspills from dredging vessels and impacts on geodiversity. These potential pathways have all been assessed in the main body of the ES for Bedwyn Sands and NMG.

The MPS also recognises the importance of the UK marine aggregate resource stating that:

> *"the extraction of marine dredged sand and gravel should continue to the extent that this remains consistent with the principles of sustainable development, recognising that marine aggregates are a finite resource and in line with the relevant guidance and legislation"*.

The MPS further acknowledges the 'crucial contribution' marine sand and gravel makes to meeting the nation's demand for construction aggregate materials, essential for the development of the UK's built environment.

Public authorities, including the MMO and NRW, must consider the adopted marine plan for all authorisations – '*any approval, confirmation, consent, licence, permission or other authorisation (however described), whether special or general*' (MCAA 2009, Section 58 (4)) - or enforcement decisions that may affect the plan area, unless relevant considerations indicate otherwise. Decision-making in relation to marine licence projects in English and Welsh waters should have regard to the appropriate marine policy document, be it the MPS or an adopted marine plan.

E.2.2 South West Marine Plans

The South West Inshore and South West Offshore Marine Plans are collectively referred to as 'the South West Marine Plans'. These were formally adopted in 2018. The South West Inshore Marine Plan area covers approximately 16,000 km^2 of sea, from mean high water springs (MHWS) out to the 12 nautical mile limit from the River Severn Border with Wales to the River Dart in Devon. The South West Offshore Marine Plan covers 68,000 km^2 of sea, from the 12 nautical mile limit to the border with Wales, France, Ireland, the Bailiwick of Guernsey and the South Offshore marine plan area.

Table E-1 reviews how the proposed aggregate extraction from Bedwyn Sands and NMG conforms to the policies of the South West Marine Plans, signposting to the relevant sections of the ES, where this has been considered in more detail. In taking a proportionate approach to applying policies, consideration has been given to the scale, complexity and impact of the proposed activity.

Overall, the proposed aggregate extraction is considered to support the policies set out in the South West Marine Plans.

E.2.3 Welsh National Marine Plan

The Welsh part of the Severn Estuary is covered by the WNMP published in November 2019 by the Welsh Government (Welsh Government, 2019). The plan covers both the Welsh inshore region (from mean high water spring tides out to 12 nautical miles) and offshore region (beyond 12 nautical miles). Unless otherwise stated, policies in this plan apply to both regions.

Table E-2 reviews how the proposed aggregate extraction from Bedwyn Sands and NMG conforms to the policies of the Welsh National Marine Plan, signposting to the relevant sections of the ES, where this has been considered in more detail. In taking a proportionate approach to applying policies, consideration has been given to the scale, complexity and impact of the proposed activity.

Overall, the proposed aggregate extraction is considered to support the policies set out in the Welsh National Marine Plan.

Table E-1 Review of the conformance of the proposed aggregate extraction from Bedwyn Sands and NMG to the South West Marine Plans

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
Infrastructure			
SW-INF-1 Proposals for appropriate marine infrastructure which facilitates land-based activities, or landbased infrastructure which facilitates marine activities (including the diversification or regeneration of sustainable marine industries), should be supported.	Many marine activities in the south west and adjacent marine plan areas are reliant on land-based infrastructure. Similarly, activities on land may also be reliant on marine infrastructure. Supporting infrastructure development, diversification and regeneration will provide socio-economic benefits and support marine businesses, including those that are land-based. SW-INF-1 supports the integration of the marine and terrestrial systems. It does so by encouraging proposals (and other measures) that maintain or improve the existing, or provide new, sustainable marine or land-based infrastructure that facilitates activity in the other system.	1	Information on the potential effects of the extraction of aggregates from Bedwyn Sands and NMG on infrastructure and other marine users is provided in Section 17 of the ES. The aggregate extraction activities will not significantly interact with any marine or landbased infrastructure/activities and/or landing facilities. Overall, the proposed activity will comply with Policies INF1 and INF2.
SW-INF-2 (1) Proposals for alternative development at existing safeguarded landing facilities will not be supported. (2) Proposals adjacent and opposite existing safeguarded landing facilities must demonstrate that they avoid significant adverse impacts on existing safeguarded landing facilities. (3) Proposals for alternative development at existing landing facilities (excluding safeguarded sites) should not be supported unless that facility is no longer viable or capable of being made viable for waterborne transport. (4) Proposals adjacent and opposite existing landing facilities (excluding safeguarded sites) that may have significant adverse impacts on the landing facilities should demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant	Landing facilities in the south west inshore marine plan area are critical for enabling industries such as shipping, tourism, recreation and leisure, construction, aggregates, and waste. By protecting existing landing facilities and identifying the difference in safeguarding, SW-INF-2 mirrors similar provisions in terrestrial planning and supports the continued operation of vital existing landing facilities.	1	
Co-existence			
SW-CO-1 Proposals that optimise the use of space and incorporate opportunities for co-existence and cooperation with existing activities will be supported. Proposals that may have significant adverse impacts on, or displace, existing activities must demonstrate that they will, in order of preference: A) Avoid B) Minimise C) Mitigate -adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	The south west marine plan areas, and in particular the inshore area, are busy areas, where space is limited. To realise sustainable social, environmental and economic benefits, it is important to plan for and make efficient use of the space. SW-CO-1 encourages proposals to be spatially planned, take account of existing activities, and to promote co-existence. The policy ensures new proposals seek to avoid creating conflicts and to minimise their footprint or optimise it where it may not be feasible to minimise.	2, 4, 6, 8, 9, 10, 11, 12, 13	The proposed aggregate extraction will not result in significant adverse effects on other marine activities or users as detailed in Section 17 of the ES. The proposed aggregate extraction will not result in significant cumulative and in-combination effects with other plans, projects and activities as detailed in Section 19 of the ES and the HRA (Appendix C). Overall, the proposed activity is considered to support Policy CO1.
Aggregates			
SW-AGG-1 Proposals in areas where a licence for extraction of aggregates has been granted or formally applied for should not be authorised, unless it is demonstrated that the proposal is compatible with aggregate extraction.	SW-AGG-1 safeguards marine aggregate licence areas from other activities unless it is demonstrated that the other activities are compatible with marine aggregate extraction. This enables continuity of the supply of construction aggregates and supports local and national objectives and economies.	2,3	The proposed activity is for the renewal of existing Aggregate Licence Areas at Bedwyn Sands and NMG and is therefore compatible with aggregate extraction. This ongoing aggregate extraction will not result in significant cumulative and in-combination effects with other plans, projects and activities, including ongoing dredging and disposal activities, as detailed in Section 19 of the ES and the HRA (Appendix C). Overall, the proposed activity is considered to support Policies AGG1, AGG2 and AGG3.
SW-AGG-2 Proposals within an area subject to an Exploration and Option Agreement with The Crown Estate should not be supported unless it is demonstrated that the proposal is compatible with aggregate extraction.	SW-AGG-2 safeguards marine aggregate Exploration and Option Agreement areas to enable the aggregate industry to explore defined areas in order to identify commercially viable aggregate resources. Proposals will only be supported if they are compatible with marine aggregate extraction. This enables the future supply of construction aggregates and supports local and national objectives and economies.	2,3	
SW-AGG-3 Proposals in areas of high potential aggregate resource that may have significant adverse impacts on future aggregate extraction should demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - significant adverse impacts on future aggregate extraction so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	SW-AGG-3 ensures that proposals consider areas of high potential aggregate resource, as defined by the British Geological Survey. It ensures that any impacts on access to commercially viable marine sand and gravel resources in the future are managed, enabling secure access to a sufficient supply of aggregate resources.	2,3	

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
Aquaculture			
SW-AQ-1 Proposals within existing or potential strategic areas of sustainable aquaculture production must demonstrate consideration of and compatibility with sustainable aquaculture production. Where compatibility is not possible, proposals that may have significant adverse impacts on sustainable aquaculture production must demonstrate that they will, in order of preference: A) Avoid B) Minimise C) Mitigate -Adverse impacts on sustainable aquaculture production so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	The policy recognises that aquaculture is an important industry with the potential to grow, contributing to food supply and security. SW-AQ-1 seeks to protect both existing aquaculture operations as well as potential future opportunities for aquaculture, within spatially defined strategic areas of sustainable aquaculture production. These strategic areas have been spatially defined for species of commercial importance by considering environmental factors, technical constraints, planning constraints and other users of the sea. The policy does not prevent non-aquaculture developments or activities; it supports sustainable aquaculture production by spatially defining areas where all proposals are required to demonstrate consideration of and compatibility with sustainable aquaculture. If this cannot be achieved, the policy stipulates proposals that may have significant adverse impacts on sustainable aquaculture should follow the steps in the mitigation hierarchy through avoiding, minimising or mitigating these impacts, before being allowed to proceed if the regulator agrees with the proponent's overriding justification. While protecting opportunities for sustainable aquaculture production, the policy makes allowances for both non-significant adverse impacts on aquaculture, and significant adverse impacts that are outweighed by the benefits of the proposal.	2,4	Information on the potential effects of the extraction of aggregates from Bedwyn Sands and NMG on the fish and shellfish, and the fishing industry is included in Sections 9 and 12 of this ES. The potential effects on these receptors are assessed as insignificant (minor adverse for direct removal of sandeel/entrainment by the dredger draghead). With regard to mitigation, standard industry measures will be observed, notably the continued application of RSMP-type monitoring, and retaining a minimum layer of sediment. Overall, the proposed activity is considered to conform with Policy AQ1.
SW-AQ-2 Proposals enabling the provision of infrastructure for sustainable aquaculture and related industries will be supported.	SW-AQ-2 aims to tackle barriers to aquaculture by encouraging the provision, maintenance and development of marine and land infrastructure to support sustainable aquaculture and related industries. This policy supports sustainable aquaculture projects by encouraging the direct development of infrastructure, as well as supporting connectivity between marine operations and land infrastructure, which will ensure that opportunities for aquaculture are realised. Due to the overlap between shoreside aquaculture and fisheries infrastructure, SW-AQ-2 supports the integration of aquaculture with the fishing industry through the sharing of infrastructure and the diversification of fishers. This policy will also benefit employment and the development of skills in coastal communities.	1,2	The proposed dredging activities do not support the provision of infrastructure for sustainable aquaculture and related industries. Policy SW-AQ-2 is therefore not relevant.
Cables			
SW-CAB-1 Preference should be given to proposals for cable installation where the method of protection is burial. Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures.	Subsea cabling is important to the growth and sustainability of telecommunications, offshore wind farms and electricity transmission. SW-CAB-1 supports and encourages cable burial where possible to meet the needs of the sector while enabling co-existence with other users of the south west marine plan areas.	3,4	There are no subsea cables (current or planned) within proximity to Bedwyn Sands and NMG, or the surrounding area. Policies CAB-1, CAB-2 and CAB-3 are therefore not relevant.
SW-CAB-2 Proposals demonstrating compatibility with existing landfall sites and incorporating measures to enable development of future landfall opportunities should be supported. Where this is not possible proposals will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts on existing and potential future landfall sites so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.	Subsea cabling is important to the growth and sustainability of telecommunications, offshore wind farms and electricity transmission. Existing and potential future landfall sites for subsea cables are not currently protected from other proposals and uses, which may prevent these sites from being used as cable landfall locations. SW-CAB-2 seeks to avoid the loss of existing and potential future landfall sites and supports all proposals that consider the requirement for future cable landfall opportunities, ensuring that socially and economically vital cable activities can continue.	1,3	
SW-CAB-3 Where seeking to locate close to existing subsea cables, proposals should demonstrate compatibility with ongoing function, maintenance and decommissioning activities relating to the cable.	SW-CAB-3 protects the ongoing function, maintenance and decommissioning of subsea cables, up to the point of landfall.	3,4	
Dredging and disposal			
SW-DD-1 In areas of authorised dredging activity, including those subject to navigational dredging, proposals for other activities will not be supported unless they are compatible with the dredging activity.	Dredge areas, and the area surrounding these that are required for dredge activity to take place, may be adversely impacted by new proposals such as those that negatively impact the ability to access or egress from these sites. SW-DD-1 ensures continued safe access by vessels to ports and harbours over the lifetime of the South West Marine Plan. This policy discourages proposals that would cause significant adverse impacts on dredge activities, such as the need for related vessels to navigate to and from authorised dredge areas.	2	The ongoing aggregate extraction at Bedwyn Sands and NMG will not result in significant cumulative and in-combination effects with other plans, projects and activities, including ongoing dredging and disposal activities, as detailed in Section 19 of the ES. Overall, the proposed activity is considered to support Policy DD1 and DD2. The proposals are for aggregate extraction and therefore Policy DD-3 is not relevant.

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
SW-DD-2 Proposals that cause significant adverse impacts on licensed disposal sites should not be supported. Proposals that may have significant adverse impacts on licensed disposal sites must demonstrate that they will, in order of preference: A) Avoid B) Minimise C)Mitigate - adverse impacts so they are no longer significant. If it is not possible to mitigate the significant adverse impacts, proposals must state the case for proceeding.	Disposal sites, and the surrounding areas that are required for the disposal activity to take place, may be adversely impacted by new proposals that negatively impact the ability to access or egress from these sites. SW-DD-2 ensures that disposal sites are not compromised, reducing the need to designate new disposal sites that are not intended for alternative use, and so reducing environmental impacts. This policy discourages proposals that would cause significant adverse impacts on disposal activities, such as the need for vessels to navigate safely to and from disposal sites. Preserving licensed disposal sites, including where sites are being used for alternative use, will enable and facilitate the growth of ports and harbours within the south west inshore marine plan area. Over the 20-year life span of the Plan, this may become more prevalent in the developing economic climate.	2	
SW-DD-3 Proposals for the disposal of dredged material must demonstrate that they have been assessed against the waste hierarchy. Where there is the need to identify new dredge disposal sites, including alternative use sites, proposals should be supported if they conform to best practice and guidance.	As a result of dredging activity, disposal of dredge material is often required, whether this is direct disposal as a last resort in the waste hierarchy or deposit of material for alternative uses. This policy ensures that proposals have considered all steps within the waste hierarchy prior to the disposal of dredge material as a last resort. The establishment of new disposal sites which are for alternative use should be supported. The establishment of new dredge disposal sites as a last resort in the waste hierarchy should only be explored after previous levels within the waste hierarchy have been considered, and the potential to utilise open, disused, or closed sites has been fully investigated and discounted. In some cases, designated disposals sites cannot be used, for example, where sediment size does not match or there are particular constraints. SW-DD-3 then provides a source of best practice and guidance for the designation of new dredge disposal sites. This is required as the demand increases for new disposal sites and encourages early consideration of impacts to avoid conflicts during the proposal process.	2	
Oil and gas			
SW-OG-1 Proposals in areas where a licence for oil and gas has been granted or formally applied for should not be authorised unless it is demonstrated that the other development or activity is compatible with the oil and gas activity.	The potential to extract oil and gas is important to the UK's energy supply. However, oil and gas exploration and production (within existing licence areas) may require access to the same area of seabed as other sector proposals. This policy protects the supply of oil and gas by safeguarding areas where there are existing licences. However, this does not sterilise areas for other activities as proposals that demonstrate compatibility with oil and gas activities may be supported. The policy gives clarity on dealing with potential future conflicts with other users who may want to use the same space as oil and gas extraction activities by supporting co-existence opportunities for different users of the south west marine plan areas. This supports the UK in meeting its energy and security objectives, as activities that may impact or sterilise areas that may be used for potential oil and gas extraction would hinder the fulfilment of the objectives of the UK Marine Policy Statement and the UK's energy objectives.	2,3	There are no oil and gas infrastructure (current or planned) within proximity to Bedwyn Sands and NMG, or the surrounding area. Hence, Policies OG-1 and OG-2 are not relevant.
SW-OG-2 Proposals within areas of geological oil and gas extraction potential demonstrating compatibility with future extraction activity will be supported.	Maximising the economic recovery of oil and gas resources may require access to discoveries of deposits that have not yet been developed. However, other proposals may require access to the same area of seabed as these resources and, therefore, to future potential oil and gas production. This policy safeguards areas identified as having geological potential for future oil and gas extraction by ensuring that proposals have regard to future oil and gas activity prior to gaining support. The policy gives clarity on dealing with potential future conflicts with other users who may want to use the same space as oil and gas extraction activities by supporting co-existence opportunities for different users of the south west marine plan areas. This supports the UK in meeting its energy and security objectives, as activities that may impact or sterilise areas that may be used for potential oil and gas extraction would hinder the fulfilment of the objectives of the UK Marine Policy Statement and the UK's energy objectives.	2,3	

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
Ports, harbours and shipping			
SW-PS-1 In line with the National Policy Statement for Ports, sustainable port and harbour development should be supported. Only proposals demonstrating compatibility with current port and harbour activities will be supported. Proposals within statutory harbour authority areas or their approaches that detrimentally and materially affect safety of navigation, or the compliance by statutory harbour authorities with the Open Port Duty or the Port Marine Safety Code, will not be authorised unless there are exceptional circumstances. Proposals that may have a significant adverse impact upon future opportunity for sustainable expansion of port and harbour activities, must demonstrate that they will, in order of preference: A) avoid B) minimise C)mitigate - adverse impacts so they are no longer significant.	Ports and harbours are essential to realising economic and social benefits for the south west marine plan areas and the UK. SW-PS-1 makes sure that proposals do not restrict current port and harbour activity or future growth, enabling long-term strategic decisions, and supporting competitive and efficient port and shipping operations. SW-PS-1 provides clarity on how the economic interests and statutory duties of ports and harbours should be protected and makes sure new development does not restrict current activities, future growth, or compliance with the Port Marine Safety Code. This policy protects the efficiency and resilience of continuing port operations and further port development (UK Marine Policy Statement, Section 3.4.7). The sustainable development of ports (increase in shipping activity) is supported by the UK Marine Policy Statement (Section 3.4.10). This policy also complements and supports the National Policy Statement for Ports, settling provisions for port growth in the context of the management and development of other activities. Policy SW-PS-1 supports the government policy for ports (National Policy Statement for Ports). It is recognised that although not all ports are able or wish to grow physically, there will remain a need to be commercially viable through adaptation, change and diversification. Also recognised is the need to ensure safe navigation both within and in the approaches to ports, at present and in the future. Harbour masters are recognised experts in navigational safety within their jurisdictional areas. Accordingly, the policy recognises that their views regarding how proposals affect safety of navigation, the Open Port Duty, and compliance with the Port Marine Safety Code should be sought and given significant weight. SW-PS-1 confirms that proposals that compromise these important duties should not be authorised unless there are exceptional circumstances. Authorisation of proposals that impact upon compliance with these core duties are expected to be exceedingly rare. This policy supports continued port maintenance and repairs, diversification and other sustainable port development that contribute to long-term economic growth and prosperity.	1,2,3	Information on the potential effects of the extraction of aggregates from Bedwyn Sands and NMG with ports, harbours and shipping is in Sections 13, 17 and 19 of the ES (Commercial and Recreational Navigation; Infrastructure and Other Existing Marine Users; and Cumulative and In-combination effects respectively). With the embedded mitigation, a risk is achieved which is considered to be as low as reasonably practicable ('ALARP'.) Overall, the proposed ongoing aggregate extraction activities are considered to comply with Policies PS1, PS2, PS3 and PS4.
SW-PS-2 Proposals that require static sea surface infrastructure or that significantly reduce under-keel clearance must not be authorised within or encroaching upon International Maritime Organization routeing systems unless there are exceptional circumstances.	Within the south west marine plan areas there are International Maritime Organization routeing systems that are essential for shipping activity, freedom of navigation, and navigational safety. SW-PS-2 confirms that proposals that compromise these important navigation routes should not be authorised. SW-PS-2 enables and supports safe, profitable and efficient marine businesses. SW-PS-2 specifies that developments should not be authorised where the use of International Maritime Organization routeing systems may be compromised. Authorisation of proposals that impact on the use of International Maritime Organization routeing systems are very rare.	1,2	
SW-PS-3 Proposals that require static sea surface infrastructure or that significantly reduce under-keel clearance which encroaches upon high density navigation routes, strategically important navigation routes, or that pose a risk to the viability of passenger services, must not be authorised unless there are exceptional circumstances.	The south west marine plan areas are very busy with respect to high-density navigation routes, strategically important navigation routes, and passenger services. SW-PS-3 confirms that proposals that pose a risk to safe navigation or the viability of these routes and services should not be authorised. SW-PS-3 aims to protect these routes and services by enabling and promoting safe, profitable and efficient marine businesses. SW-PS-3 focuses on minimising negative impacts on shipping activity, protecting the economic interests of ports, harbours, shipping and the UK economy overall, and affording protection to the areas used by high intensities of traffic (UK Marine Policy Statement, Section 3.4.2). It also gives effect to provisions in the National Planning Policy Framework (Section 37), which aims to encourage sustainable transport.	1,2	
SW-PS-4 Proposals promoting or facilitating sustainable coastal and/or short sea shipping as an alternative to road, rail or air transport will be supported where appropriate.	Short sea shipping provides a sustainable alternative for the transport of goods. SW-PS-4 aims to support sustainable coastal or short sea shipping where appropriate as an alternative to road, rail or air methods lowering carbon dioxide emissions and reducing road congestion. Bulk volumes are moved quickly with a reduction in administrative burden and increased efficiency through economies of scale. Short sea routes	3	

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
	also allow the transhipment of cargo from large vessels landing into major European ports to the UK (and through direct movements of smaller bulk materials), reducing costs, improving reliability, and allowing smaller ports to expand through the establishment of increased numbers of short sea shipping routes where suitable. Policy SW-PS-4 supports the government policy for ports (National Policy Statement for Ports, Section 3.1.4, Section 3.3.5 and Section 3.4.14). The short sea shipping market is expected to grow over the lifetime of the marine plan, providing a flexible and specialised service.		
Renewables			
SW-REN-1 Proposals that enable the provision of renewable energy technologies and associated supply chains, will be supported.	Supply chains play an important role in developing technology, reducing the associated costs of infrastructure, and realising the economic and social benefits of renewable energy to the UK economy. SW-REN-1 recognises the importance of the supply chain within the lifecycle of renewable energy projects. SW-REN-1 enables public authorities to support proposals that will reduce costs, ensuring that businesses are operating competitively and with a long-term strategy. Developing a strong supply chain will not only support the domestic installation of offshore wind but could contribute to establishing a successful export market, particularly in relation to the emerging floating offshore wind industry. The Offshore Wind Sector Deal outlines a commitment to increase UK supply chain content to 60% by 2030. This policy supports proposals that indicate how they will draw on and develop the UK supply chain as part of their development.	2,3,8	This is not directly applicable, although, as noted previously, the proposed aggregate extraction area will support the regional (and wider) construction industry; this could include windfarm infrastructure construction, notably foundations. Overall, the proposed activity is considered to support Policies REN1, REN2 and REN3.
SW-REN-2 Proposals for new activity within areas held under a lease or an agreement for lease for renewable energy generation should not be authorised, unless it is demonstrated that the proposed development or activity will not reduce the ability to construct, operate or decommission the existing or planned energy generation project.	Renewable energy technologies contribute to the diversification and decarbonisation of the electricity grid. SW-REN-2 protects areas identified for energy developments from other activities that could affect the sites' ability to generate energy. It enables the development of safe, profitable and efficient marine businesses.	2,3,8	
SW-REN-3 Proposals for the installation of infrastructure to generate offshore renewable energy, inside areas of identified potential and subject to relevant assessments, will be supported.	Offshore wind is the current favoured offshore renewable energy generating technology in the UK. The 'offshore wind high potential future development areas' layer highlights areas of least constraint for fixed foundation offshore wind energy generation and indicates potential future areas for leasing. This dataset reflects the latest understanding of areas with high potential, incorporating the original technical constraints analysis (see the "Resource and Constraints Assessment Methodology Report" available on the Marine Data Exchange). SW-REN-3 supports the identification of future leasing rounds and provides a level of certainty for other activities as to where future development may occur. Figure 13 identifies the portion of the plan areas that has a high potential for the future development of offshore wind. SW-REN-3 is in place to facilitate the identification of sites for future marine renewable energy development. Spatial areas for all technology types will be updated as required, based on improved understanding of constraints and technical advancements in new technology. Proponents and decision-makers should refer to Explore Marine Plans for the most up-to-date data.	2,3,8	
Heritage assets			
SW-HER-1 Proposals that demonstrate they will conserve and enhance the significance of heritage assets will be supported. Where proposals may cause harm to the significance of heritage assets, proponents must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - any harm to the significance of heritage assets. If it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets.	This policy aims to conserve and enhance marine and coastal heritage assets by considering the potential for harm to their significance. This consideration will not be limited to designated assets and extends to those non-designated assets that are, or have the potential to become, significant. The policy will ensure that assets are considered in the decision-making process and will make provisions for those assets that are discovered during developments.	5,6,9	Observing the mitigation hierarchy is standard practice of any EIA, so the EIA undertaken for Bedwyn Sands and NMG has fully considered this for all of the assessed receptors (see Section 4.4 of the ES for the EIA methodology applied), including marine archaeology. Potential impacts on marine archaeology have been assessed in Section 14 of the ES; this also fully explains the minimising and mitigating actions proposed. The ES concluded that, based on the proposed mitigation measures, it is considered that the residual overall impact on marine archaeological receptors can be reduced to minor adverse at worst. Overall, the proposed aggregate extraction is considered to conform to Policy HER1.
Seascape and landscape			
SW-SCP-1 Proposals should ensure they are compatible with their surroundings and should not have a significant adverse impact on the character and	The aim of the policy is to manage significant adverse impacts on the seascape and landscape of the south west inshore and offshore marine plan areas. It will make sure that an area's value, quality, and its capacity	5,9	The proposed aggregate extraction will not give rise to landscape/seascape and visual impact effects and, therefore, this topic has been scoped out of the EIA. Policy SCP1 is, therefore, not considered relevant.

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
visual resource of the seascape and landscape of the area. The location, scale and design of proposals should take account of the character, quality and distinctiveness of the seascape and landscape. Proposals that may have a significant adverse impact on the seascape and landscape of the area should demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant. If it is not possible to mitigate, the public benefits for proceeding with the proposal must outweigh significant adverse impacts to the seascape and landscape of the area. Proposals within or relatively close to nationally designated areas should have regard to the specific statutory purposes of the designated area. Great weight should be given to conserving and enhancing landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty.	to accommodate change is considered and that the scale and design of a proposal is compatible with its surroundings. The policy's primary aim is to make provisions for those areas of seascape without statutory designation. The policy also supports those areas with existing statutory designation, such as National Parks, Areas of Outstanding Natural Beauty and World Heritage Sites. Defined Heritage Coasts are also supported, although they do not hold statutory designation.		
Fisheries			
SW-FISH-1 Proposals that support a sustainable fishing industry, including the industry's diversification, should be supported.	Commercial fisheries can be affected by changes to fish abundance, growth, distribution or behaviour. SW-FISH-1 supports long-term strategic proposals that enable the fishing industry to diversify or build in resilience to manage climate change risks and maximise opportunities for sustainable use of marine resources.	3,4	Information on the potential effects of the extraction of aggregates from Bedwyn Sands and NMG on the fishing and shellfish and the fishing industry is included in Sections 9 and 13 of this ES. Potential effects are assessed as insignificant, apart from the potential removal of sandeel/entrainment by the dredger draghead which is assessed as insignificant to minor adverse. With regard to mitigation, standard industry measures will be observed, notably the continued application of RSMP-type monitoring and retaining a minimum layer of sediment. Overall, the proposed development is considered to conform to Policies FISH1, FISH2, and FISH3.
SW-FISH-2 Proposals that enhance access for fishing activities should be supported. Proposals that may have significant adverse impacts on access for fishing activities must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding	A sustainable fishing industry provides benefits to coastal communities and contributes to UK food security. Fisheries activities are restricted in where and when they can operate, making the access to these activities vulnerable. SW-FISH-2 supports enhanced access for sustainable fishing activities and seeks to limit significant adverse impacts from other marine activities on access for fishing activities, enabling continued sustainable marine resource use and generating prosperous, resilient and cohesive coastal communities. This policy covers not only fishing activity, but also the transit routes to and from sites and any berthing/beaching or landing/loading points.	2,9	
SW-FISH-3 Proposals that enhance essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, should be supported. Proposals that may have significant adverse impacts on essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Sustainable fish populations rely upon specific habitats throughout their life. SW-FISH-3 recognises that the protection of habitats and the services they provide can enhance fish populations, supporting the long-term existence of the fisheries and contributing to Good Environmental Status, as detailed in the Marine Strategy Part One: UK updated assessment and Good Environmental Status. SW-FISH-3 encourages and supports proposals that deliver biodiversity gain for essential fish habitats. SW-FISH-3 enables sustainable use of marine resources within environmental limits, alongside productive fisheries, by requiring proposals to avoid impacts on essential fish habitats or, if avoidance of impacts is not possible, to manage impacts on essential fish habitats.	11,12,13	
Employment			
SW-EMP-1 Proposals that result in a net increase in marine related employment will be supported, particularly where they meet one or more of the following: 1) are aligned with local skills strategies and support the skills available 2) create a diversity of opportunities 3) create employment in locations identified as the most deprived 4) implement new technologies - in, and adjacent to, the south west marine plan areas.	The creation and maintenance of quality jobs is a key component to delivering sustainable economic growth, and for ensuring that everyone is able to access its associated opportunities (Employment and Skills Strategies in England, United Kingdom). SW-EMP-1 supports existing national policies and strategies (e.g. the UK Marine Policy Statement and the UK's Industrial Strategy: building a Britain fit for the future) by encouraging decision-makers and proponents to deliver additional employment benefits from proposals, particularly those benefits associated with the listed policy criteria. SW-EMP-1 seeks to maximise sustainable economic activity, prosperity and opportunities for all, both now and into the future.	2,4	The proposed aggregate extraction will support the regional construction industry by helping to make sure essential resources continue to be available. Furthermore, direct employment at the wharves and on vessels is supported. All skill levels are supported with regard to direct and indirect employment benefits arising from dredging in Bedwyn Sands and NMG, from high-skilled technicians, roles in the supporting logistic chain and administrative and management roles. By renewing the licence for Bedwyn Sands and NMG, this helps to maintain jobs already in place, ensuring continued employment in the South West of England. Overall, the proposed aggregate extraction is considered to support Policy EMP1.
Climate Change			
SW-CC-1 Proposals that conserve, restore or enhance habitats that provide flood defence or carbon sequestration will be supported. Proposals that may have significant adverse impacts on habitats that provide a flood defence or carbon sequestration ecosystem service must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant	Proposals that conserve, restore or enhance habitats that provide flood defence or carbon sequestration will be supported. Habitats that provide flood defence and carbon sequestration contribute to natural resilience for coastal communities that are vulnerable to coastal erosion and change. SW-CC-1 requires proposals to manage impacts, enabling these important habitats to continue to provide this valuable service. Proposals that cannot avoid, minimise and mitigate or, or as a last resort, compensate for significant adverse impacts, will not be supported.	6,8,11,12	The proposed aggregate extraction will not materially alter the impacts of climate change or be impacted by the effects of climate change. Emissions from the small number of vessels associated with the aggregate extraction from Bedwyn Sands and NMG will be negligible in the context of existing vessel movements (see Sections 13 and 16 of the ES). The British marine aggregates industry (including Breedon) is committed to progressively reducing its carbon footprint; amongst others by introducing new, more efficient, vessels to their fleet. In addition, by potentially acting as a source of beach nourishment material, Bedwyn Sands and NMG could aid in climate change adaptation.

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
d) compensate for significant adverse impacts that cannot be mitigated.			Overall, the proposed aggregate extraction is considered to conform and support Policies CC1, CC2 and CC3.
SW-CC-2 Proposals in the south west marine plan areas should demonstrate for the lifetime of the project that they are resilient to the impacts of climate change and coastal change.	The effects of climate change are wide-ranging and can include sea level rise, coastal flooding and rising sea temperatures. SW-CC-2 adds provision to enable enhanced resilience of developments, activities and ecosystems within the south west marine plan areas to the effects of climate change and coastal change.	3,6	
SW-CC-3 Proposals in the south west marine plan areas, and adjacent marine plan areas, that are likely to have significant adverse impacts on coastal change, or on climate change adaptation measures inside and outside of the proposed project areas, should only be supported if they can demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Large areas of the south west inshore marine plan area coastline are subject to or vulnerable to change. SW-CC-3 ensures proposals do not exacerbate coastal change, enabling communities to be more resilient and better able to adapt to coastal erosion and flood risk where identified. SW-CC-3 also supports proposals that do not compromise existing adaptation measures, which will enable an improvement in the resilience of coastal communities to coastal erosion and flood risk. Proposals that cannot avoid, minimise and mitigate significant adverse impacts will not be supported.	3,6,11,12	
Air quality and emissions			
SW-AIR-1 Proposals must assess their direct and indirect impacts upon local air quality and emissions of greenhouse gases. Proposals that are likely to result in increased air pollution or increased emissions of greenhouse gases must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - air pollution and/or greenhouse gas emissions in line with current national and local air quality objectives and legal requirements.	Clean air is essential for life, health, the environment and the economy. Air pollution and greenhouse gas emissions must be reduced to protect health, habitats and species and reduce the impacts of climate change. SW-AIR-1 ensures that proposals consider and address where they may cause direct or indirect air pollution or greenhouse gas emissions and manage these accordingly. Proposals that cannot avoid, minimise or mitigate air pollution and/or greenhouse gas emissions in line with current national or local air quality objectives and legal requirements must not be supported.	3,7	Information on the potential effects of the extraction of aggregates from Bedwyn Sands and NMG on Air Quality is assessed in Section 16 of this ES. The effects are assessed as insignificant and will not require any mitigation. Overall, the proposed activity is considered to conform to Policy AIR1.
Marine litter			
SW-ML-1 Public authorities must make adequate provision for the prevention, re-use, recycling and disposal of waste to reduce and prevent marine litter. Public authorities should aspire to undertake measures to remove marine litter within their jurisdiction.	Litter at sea often originates on land. Increase in development, access, recreation and tourism in the south west marine plan areas may result in increased litter, and an adverse impact on the environment on which these activities rely. Preventing marine litter through effective waste management is vital. Addressing marine litter along the coastline is also an important step towards dealing with this problem.	7,11	Whilst not assessed in the ES, the industry best practice is being observed by the Breedon Group. Overall, the proposed activity is therefore considered to conform to Policies ML-1 and ML-2.
SW-ML-2 Proposals that facilitate waste re-use or recycling to reduce or remove marine litter will be supported. Proposals that could potentially increase the amount of marine litter in the marine plan areas must include measures to, in order of preference: a) avoid b) minimise c) mitigate - waste entering the marine environment.	The natural landscapes, wildlife and recreational opportunities on offer in the marine plan areas attract visitors to the area. An increase in visitors and in coastal and marine development could lead to an increase in litter. SW-ML-2 makes sure proposals avoid, minimise or mitigate waste entering the marine environment and encourages support for improvements in waste management and removal of marine litter, during construction and over the lifetime of the development. Proposals that cannot avoid, minimise or mitigate waste entering the marine environment will not be supported.	7,11	
Water quality			
SW-WQ-1 Proposals that protect, enhance and restore water quality will be supported. Proposals that cause deterioration of water quality must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - deterioration of water quality in the marine environment.	Much of the economic and cultural prosperity of the south west marine plan areas is reliant on water quality. Activities can place stress on water bodies such that, in parts of the south west marine plan areas, water quality requires improvement. SW-WQ- 1 supports activities with a primary objective to protect, enhance and restore water quality. SW-WQ-1 also manages activities that may cause deterioration of water quality by ensuring that adverse impacts from proposals must be avoided, minimised and mitigated. With the exception of the derogations identified in Sections 17 and 19 of The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, there should be no residual adverse impacts on inshore water bodies. From one nautical mile out to the outer limit of the UK Exclusive Economic Zone, there should be no adverse impacts on water quality, in line with The Marine Strategy Regulations 2010.	7,11	The proposed aggregate extraction will not result in any significant adverse effects on water and sediment quality. Further details are provided in the water and sediment quality assessment in Section 6 of the ES. Overall, the proposed aggregate extraction is considered to conform to Policy WQ1.
Access			
SW-ACC-1 Proposals demonstrating appropriate enhanced and inclusive public access to and within the marine area, including the provision of services for tourism and recreation activities, will be supported.	The provision of appropriate public access is essential for realising the economic, environmental, and social benefits associated with the growth of sustainable tourism and recreation within the south west marine plan areas. SW-ACC-1 supports proposals for appropriate	6,9	The proposed aggregate extraction will not result in an effect on public access to and within the marine area. The potential interactions with other vessels and activities are not considered significant as detailed in Sections 12, 13 and 17. Overall, Policy ACC1 is therefore not considered relevant.

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
Proposals that may have significant adverse impacts on public access should demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	enhanced and inclusive public access to, and within, the marine area, including those providing services for tourism and recreation activities. SW-ACC-1 also provides clarity on how public access should be protected and ensures that proposals do not have significant adverse impact on existing public access. Where proposals cannot avoid, minimise or mitigate significant adverse impacts to public access, they should not be supported. While SW-ACC-1 supports and protects public access to the marine area, in some circumstances, access restrictions may be required. Where they are incompatible with existing or proposed access restrictions, proposals for the provision of new public access should not be supported.		
Tourism and recreation			
SW-TR-1 Proposals that promote or facilitate sustainable tourism and recreation activities, or that create appropriate opportunities to expand or diversify the current use of facilities, should be supported. Proposals that may have significant adverse impacts on tourism and recreation activities must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Tourism and recreation are widely recognised as very important sectors within the south west marine plan areas, providing numerous economic and social benefits to coastal communities and visitors to the region. SW-TR-1 supports these growth industries through the promotion of sustainable tourism and recreation at appropriate locations. It also encourages diversification of activities – for example, through the extension of operating seasons or development of alternative uses for facilities – to create additional employment opportunities, while reducing adverse impacts on natural resources and heritage assets. To minimise stakeholder conflict, this policy also addresses the potential impact of proposals on existing tourism and recreation use, or future potential activities; those proposals that cannot avoid, minimise and mitigate significant adverse impacts on tourism and recreation activities are unlikely to be supported.	6,9	The proposed activities will have an insignificant cumulative and in-combination effects with other plans, projects and activities, including tourism and recreation activities, as detailed in Section 19 of the ES and the HRA (Appendix C). Overall, the proposed aggregate extraction is considered to conform to Policy TR1.
Social benefits			
SW-SOC-1 Those bringing forward proposals should consider and demonstrate how their development shall enhance public knowledge, understanding, appreciation and enjoyment of the marine environment as part of (the design of) the proposal.	SW-SOC-1 seeks to increase the general knowledge, understanding, appreciation and enjoyment by people of the many values provided by the marine environment through encouraging proposals that incorporate these factors.	5,6,9	This is not directly applicable, although, as noted previously, the proposed aggregate extraction area could supply materials for beach nourishment, with beaches providing health and social well-being benefits and further provide employment. Overall, the proposed activity is considered to support Policy SOC1.
Defence			
SW-DEF-1 Proposals in or affecting Ministry of Defence areas should only be authorised with agreement from the Ministry of Defence.	There are a high number of defence activities and estates in the south west marine plan areas. Marine infrastructure can affect their continuity or future use. SW-DEF-1 aims to avoid conflict between defence activities and new proposals within the south west marine plan areas. This policy will ensure defence interests are not hindered.	10	As noted in Section 17 of the ES, there are no Ministry of Defence Danger and Exercise Areas at, or near, Bedwyn Sands and NMG. Policy DEF1 is therefore not considered relevant.
Marine protected areas			
SW-MPA-1 Proposals that support the objectives of marine protected areas and the ecological coherence of the marine protected area network will be supported. Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate adverse impacts - adverse impacts, with due regard given to statutory advice on an ecologically coherent network.	Marine protected areas in the south west marine plan areas make a significant contribution towards the UK's network of ecologically coherent marine protected areas. SW-MPA-1 encourages and supports proposals for activities that further the conservation objectives of marine protected areas. SW-MPA-1 also ensures proposals take account of adverse impacts on individual sites and the overall network, protecting important habitats, species and geological features, and enabling the successful and continued management of these sites. Proposals that cannot avoid, minimise or mitigate adverse impacts should not be supported.	11,12,13	The proposed aggregate extraction is not considered to result in a potential adverse effect on integrity (AEOI) on any European/Ramsar sites or conservation objectives of European/Ramsar sites, either alone or in-combination with other activities, plans or projects. Further information is provided in the HRA (Appendix C). In addition, there is considered to be no significant risk that the proposed aggregate extraction will affect any MCZ interest features, given that the nearest MCZ is the C Bideford to Foreland Point MCZ, which is located over 50 km from Bedwyn Sands and NMG. Overall, the proposed aggregate extraction is considered to conform to Policy MPA1, MPA2, MPA3 and MPA4.
SW-MPA-2 Proposals that enhance a marine protected area's ability to adapt to climate change, enhancing the resilience of the marine protected area network, will be supported. Proposals that may have adverse impacts on an individual marine protected area's ability to adapt to the effects of climate change, and so reduce the resilience of the marine protected area network, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts.	The effects of climate change on habitats and species poses a challenge to designated marine protected area sites in the south west marine plan areas. SW-MPA-2 ensures proposals account for adverse impacts on each impacted individual marine protected area's ability to adapt to climate change, improving resilience and working towards a well managed marine protected area network. Proposals that cannot avoid, minimise or mitigate adverse impacts should not be supported.	11,12,13	
SW-MPA-3 Where statutory advice states that a marine protected area site condition is deteriorating or that features are moving or changing due to climate change, a suitable boundary change to ensure continued	Anthropogenic activities such as the burning of fossil fuels, deforestation, farming, and methane release from animal farming have serious adverse impacts on the climate. These impacts include, but are not limited to, increased ocean acidity, temperature shifts, and	11,12,13	

South West Marine Plan Policies	Policy Aim	Related Objective(s)	Review of Project Conformance
protection of the site and coherence of the overall network should be considered.	increased storm activity. Climate change may result in marine protected area feature migration and/or feature displacement due to shifts in ranges of habitats and species. SW-MPA-3 ensures flexibility by supporting boundary changes to improve the resilience of the marine protected 11, 12, 13 247 area network. SW-MPA-3 enables adaptive management to help mitigate the loss of features within sites, and support adaptation to climate change.		
SW-MPA-4 Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Geodiversity in the south west marine plan areas has formed over billions of years. With natural change happening slowly over a long timescale, geodiversity is particularly vulnerable to human impacts. SW-MPA-4 makes sure proposals account for significant adverse impacts on designated geodiversity protecting important geological and geomorphological features that underlie and determine the character of our landscape and seascape. Proposals that cannot avoid, minimise or mitigate significant adverse impacts should not be supported.	11	
Biodiversity			
SW-BIO-1 Proposals that enhance the distribution of priority habitats and priority species will be supported. Proposals that may have significant adverse impacts on the distribution of priority habitats and priority species must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant d) compensate for significant adverse impacts that cannot be mitigated.	Maintaining the distribution of priority habitats and priority species in the south west marine plan areas is important as it reduces habitat fragmentation, species isolation and supports strong, biodiverse communities which in turn provide ecosystem services. SW-BIO-1 encourages and supports proposals that enhance the distribution of priority habitats and priority species. SW-BIO-1 seeks to maintain the distribution of priority habitats and priority species through the management of significant adverse impacts. Proposals that cannot avoid, minimise and mitigate or, as a last resort, compensate for significant adverse impacts, will not be supported.	11,12,13	The scale and nature of the aggregate extraction from Bedwyn Sands and NMG is not considered to result in any significant adverse impacts on marine and terrestrial biodiversity that are not possible to avoid and/or minimise to environmental acceptable levels through the application of appropriate mitigation measures. Further details on the nature conservation and marine ecology effects of the proposed aggregate extraction from Bedwyn Sands and NMG are included in Sections 7 to 11 of the ES, and the also in the HRA (Appendix C). Overall, the proposed development is considered to conform to Policies BIO1, BIO2, BIO3 and HAB1.
SW-BIO-2 Proposals that enhance or facilitate native species or habitat adaptation or connectivity, or native species migration, will be supported. Proposals that may cause significant adverse impacts on native species or habitat adaptation or connectivity, or native species migration, must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant d) compensate for significant adverse impacts that cannot be mitigated.	Competition for space, increased levels of development, and the predicted effects of climate change can affect the connectivity, adaptive ability and migration of habitats and species in the south west marine plan areas. SW-BIO-2 supports and encourages proposals that enhance or facilitate native species or habitat adaptation or connectivity, or native species migration. SW-BIO-2 requires proposals to manage negative effects which may significantly adversely impact the functioning of healthy, resilient and adaptable marine ecosystems. Proposals that cannot avoid, minimise and mitigate or, as a last resort, compensate for significant adverse impacts, will not be supported.	11,12,13	
SW-BIO-3 Proposals that conserve, restore or enhance coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, will be supported. Proposals must take account of the space required for coastal habitats, where important in their own right and/or for ecosystem functioning and provision of ecosystem services, and demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate d) compensate for - net habitat loss.	In the south west inshore marine plan area, there are numerous important coastal habitats. Increased competition for space in and around these coastal habitats in the south west inshore marine plan area has resulted in coastal squeeze, a process where habitats have decreasing space between rigid coastal structures and rising sea level or coastal erosion. SW-BIO-3 encourages and supports proposals that deliver biodiversity gain by conserving, enhancing or restoring coastal habitats. SW-BIO-3 also requires proposals to manage net habitat loss as a result of coastal squeeze to support the functioning of healthy and resilient coastal and intertidal ecosystems. Proposals that cannot avoid, minimise and mitigate or, as a last resort, compensate for net habitat loss, will not be supported.	8,11,12,13	
SW-HAB-1 Proposals that incorporate measures to conserve deep sea habitats will be supported. Proposals that may have direct adverse impacts on deep sea habitats must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - direct adverse impacts on deep sea habitats.	Deep sea habitats in the south west offshore marine plan area are the only example of deep sea habitats in English waters. These habitats are vulnerable to change due to their slow rate of growth and recovery following disturbance and damage. SW-HAB-1 supports and encourages proposals that incorporate measures to conserve deep sea habitats. SW-HAB1 requires proposals to manage their impacts on these habitats to support the functioning of healthy and resilient deep sea habitats. Proposals that cannot avoid, minimise and mitigate for adverse impacts will not be supported.	11,12	
Invasive non-native species			
SW-INNS-1 Proposals that reduce the risk of introduction and/or spread of invasive non-native species should be supported. Proposals must put in place	The south west marine plan areas are particularly busy and, as a result, there is a high risk of introducing or spreading invasive non-native species which may damage the marine area and harm populations of	7,11,12,13	The risk of introducing and spreading invasive non-native species assessed in Section 8 of the ES. In order to manage potential non-native species risks during aggregate extraction, a Biosecurity Plan will be

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appropriate measures to avoid or minimise significant adverse impacts that would arise through the introduction and transport of invasive non-native species, particularly when: 1) moving equipment, boats or livestock (for example fish or shellfish) from one water body to another 2) introducing structures suitable for settlement of invasive non-native species, or the spread of invasive non-native species known to exist in the area.	native flora and fauna. SW-INNS-1 aims to avoid or minimise damage to the marine area from the introduction or transport of invasive non-native species. Proposals that do not put in place appropriate measures to avoid or minimise significant adverse impacts that would arise through the introduction and transport of invasive non-native species will not be supported. SW-INNS-1 also aims to support those projects that attempt to reduce the risk and/or introduction of invasive non-native species, such as eradication projects.		produced in accordance with best practice guidance (this is proposed for the pre-dredge phase, should a licence be granted). Overall, the proposed activity is considered to comply with Policy INNS1 and INNS2.
SW-INNS-2 Public authorities with functions to manage activities that could potentially introduce, transport or spread invasive non-native species should implement adequate biosecurity measures to avoid or minimise the risk of introducing, transporting or spreading invasive non-native species.	SW-INNS-2 aims to avoid or minimise the introduction and spread of marine invasive non-native species by encouraging public authorities with relevant functions throughout the south west to implement adequate biosecurity measures, increase awareness of invasive non-native species and provide suitable guidance to help reduce their adverse impacts on the marine environment, which could include the eradication of existing invasive species.	7,11,12,13	
Disturbance			
SW-DIST-1 Proposals that may have significant adverse impacts on highly mobile species through disturbance or displacement must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts so they are no longer significant.	Disturbance and displacement from activities, including those that do not require authorisation such as tourism and recreation, can cause declines in some highly mobile species. SW-DIST-1 reduces the effects of disturbance and displacement by requiring proposals to manage impacts, highlighting good practice and encouraging strategic management of unauthorised activities. SW-DIST-1 enables people to appreciate marine biodiversity and act responsibly to protect and recover populations of rare, vulnerable and valued species. Proposals that cannot avoid, minimise and mitigate significant adverse impacts will not be supported.	11,12,13	The potential disturbance and displacement impacts of the proposed dredging activities on mobile species have been assessed in Sections 9 to 11 of the ES. No significant effects have been identified. Overall, the proposed activities are considered to comply with Policy DIST1.
Underwater noise			
SW-UWN-1 Proposals that result in the generation of impulsive sound must contribute data to the UK Marine Noise Registry as per any currently agreed requirements. Public authorities must take account of any currently agreed targets under the Marine Strategy Part One Descriptor 11.	Impulsive sounds can have an adverse effect on marine life and human enjoyment of marine areas. SW-UWN-1 supports the established noise registry to determine baselines, levels of impulsive sound and management options through the recording and assessment of the distribution and timing of impulsive sound sources in the marine environment. This will enable effective marine management and protection of biodiversity or viable populations of species.	13	The continued aggregate extraction activities at Bedwyn Sands and NMG will not generate impulsive sound and therefore Policy UWN1 is not relevant. As detailed in Sections 8, 9 and 11 of the ES, the proposed activities will not result in any significant adverse underwater noise effects. The proposed activities are, therefore, considered to comply with Policy UWN2.
SW-UWN-2 Proposals that result in the generation of impulsive or non-impulsive noise must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse impacts on highly mobile species so they are no longer significant. If it is not possible to mitigate significant adverse impacts, proposals must state the case for proceeding.	Underwater noise levels have increased with marine space use. Noise can affect highly mobile species, including causing chronic stress and death at higher intensities. SW-UWN-2 supports management of underwater noise, requiring proposals to take appropriate noise reduction actions. SW-UWN-2 enables clear and proportionate regulation to make sure marine activity respects environmental limits and protects biodiversity.	11,13	
Cumulative effects			
SW-CE-1 Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order of preference: a) avoid b) minimise c) mitigate - adverse cumulative and/or in-combination effects so they are no longer significant.	While cumulative effects are considered in relevant assessments and decision-making, the increasing use of the marine area reinforces the need to consider and address cumulative effects of both terrestrial and maritime projects, in line with the aims set out in the UK Marine Policy Statement. In conjunction with and in support of other relevant south west plan policies, this policy is intended to ensure relevant effects, including those that may seem less significant in their own right, are taken account of and addressed. In doing so, the policy will help to ensure that the cumulative effect on the wider environment of the south west marine area and other relevant receptors are effectively managed.	2,3,4,6,11,12,13	The potential cumulative and in-combination effects of the continued extraction activities at Bedwyn Sands and NMG have been assessed in Section 19 of the ES. The proposed activities alone (intra-project effects) and other plans, projects and/or activities (inter-project effects) will not result in any significant adverse cumulative and/or in-combination effects. Overall, the proposed activities are considered to comply with Policy CE1.
Cross-border co-operation			
SW-CBC-1 Proposals must consider cross-border impacts throughout the lifetime of the proposed activity. Proposals that impact upon one or more marine plan areas or terrestrial environments must show evidence of the relevant public authorities (including other countries) being consulted and responses considered.	SW-CBC-1 requires a considered approach to enhance cross-border co-operation between the terrestrial and marine planning systems in the south west marine plan areas, the bordering English south marine plan areas, and the neighbouring jurisdictions of Wales, France, Ireland and the Bailiwick of Guernsey.	1-13 (all plan objectives)	Policy CBC1 is directed towards public authorities to consider the cross-border and plan compatibility of the project and is therefore not relevant to the proposed aggregate extraction licence renewal application.

Table E-2 Review of the conformance of the proposed aggregate extraction from Bedwyn Sands and NMG to the Welsh National Marine Plan

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
GEN_01	Planning policy	There is a presumption in favour of the sustainable development of the plan area in order to contribute to Wales' well-being goals.	Project will have a positive impact on this policy.	As noted in the WNMP, it is recognised 'that an adequate and continuing supply of aggregates is essential to meet demand for construction needs for the built environment'. Furthermore, the WNMP notes that 'whilst marine aggregates extraction 'may cause a range of environmental impacts, overall marine dredging can have distinct economic and environmental advantages in comparison with land-based quarrying'. This was highlighted in Section 2.3 of the ES. Section 18 of the ES, on Human Health, discussed the seven wellbeing goals as set out in the Well Being of Future Generations (Wales) Act 2015, and the ES concluded that impacts on human health would be insignificant. The British marine aggregates industry (including Breedon) is committed to sustainable development. They recognise that the environment in which they operate is sensitive, and that they are extracting a finite resource. They accept the responsibility to manage their operations in ways that minimise any effects on the marine environment and its other users. Furthermore, the industry is committed to the careful management of both their licence areas and their production operations, to ensure that these valuable resources are able to be used in the most efficient and effective manner possible.
GEN_02	Planning policy	Relevant public authorities should take a proportionate, risk-based approach to application of relevant marine planning policies in decision making.	Policy is not applicable to the applicant for the project.	This policy is directed towards public authorities to encourage a proportionate and risk-based approach to decision making and is therefore not applicable to the application.
ECON_01	Sustainable economic growth	Proposals for economically sustainable activities are encouraged, particularly where they contribute to: • the sustainable management of natural resources thereby supporting ecosystem resilience; • a more resilient economy; • employment opportunities particularly for coastal communities; • protecting and creating employment at all skill levels; • maintaining communities with a high-density of Welsh speakers; and/or • tackling poverty by supporting deprived coastal communities.	Project will have a positive impact on this policy.	As noted against Policy GEN_01, it is recognised in the WNMP that a constant supply of aggregates is required to sustain construction needs. The WNMP specifically highlights that 'marine aggregates play a strategically important role in the national and local supply of aggregates, predominantly for use in construction projects. The sector therefore makes a critical contribution to the Welsh economy, providing both direct employment and secondary employment in supporting activities including ship building and repair, processing of aggregates at wharves and transportation and manufacture of products such as ready-mixed concrete and concrete products, asphalt and mortar from marine aggregates.' The industry is committed to sustainable development and recognises that marine aggregates are a finite resource, the use of which needs to be carefully managed. The Breedon Group is fully supportive of this goal, as noted against Policy GEN_01.
ECON_02	Coexistence	Proposals should demonstrate how they have considered opportunities for coexistence with other compatible sectors in order to optimise the value and use of the marine area and marine natural resources.	Project will have a positive impact on this policy.	Whilst dredging, other activities have to necessarily be excluded from a dredging area. However, when not in the area, some activities, notably fishing, can be undertaken. As outlined in the ES (Section 12 of the ES), no commercial or recreational fishing takes place in the vicinity of Bedwyn Sands and NMG.
SOC_01	Access to the marine environment	Proposals that maintain or enhance access to the marine environment are encouraged.	Policy is not applicable to the applicant for the project.	Not applicable.
SOC_02	Well-being of coastal communities	Proposals that contribute to the well-being of coastal communities are encouraged.	Project will have a positive impact on this policy.	See GEN_01. As noted above, the proposed aggregate extraction activities help facilitate the continued development of communities by supplying much needed aggregates to the construction industry, but also sometimes coastal defence projects such as beach nourishment.
SOC_03	Marine pollution incidents	Proposals should demonstrate how they minimise their risk of causing or contributing to marine pollution incidents.	Project will support this policy.	Section 13 of the ES assesses impacts related to commercial and recreational navigation, including pollution risk related to collisions and other hazards. Minimising measures are set out, most notably adherence to the existing industry good practice for ensuring navigation safety during aggregate dredging operations (BMAPA, 2012).
SOC_04	Welsh language and culture	Proposals that contribute to the promotion and facilitation of the use of the Welsh language and culture are encouraged.	Policy is not applicable to the applicant for the project.	Not applicable.
SOC_05	Historic assets	Proposals should demonstrate how potential impacts on historic assets and their settings have been taken into consideration and should, in order of preference: a) avoid adverse impacts on historic assets and their settings; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Opportunities to enhance historic assets are encouraged.	Project will conform to this policy.	Observing the mitigation hierarchy is part and parcel of any EIA, so the EIA undertaken for Bedwyn Sands and NMG has fully considered this for all of the assessed receptors (see Section 4.4 of the ES for the EIA methodology applied), including marine archaeology. Potential impacts on marine archaeology have been assessed in Section 14 of the ES; this also fully explains the minimising and mitigating actions proposed. The ES concluded that, based on the proposed mitigation measures, it is considered that the residual overall impact on marine archaeological receptors can be reduced to minor adverse at worst.
SOC_06	Designated landscapes	Proposals should demonstrate how potential impacts on the purposes and special qualities for which National Parks or Areas of Outstanding Natural Beauty have been designated have been taken into consideration and should, in order of preference: a) avoid adverse impacts on designated landscapes; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Opportunities to enhance designated landscapes are encouraged.	Project will not impact on this policy.	No National Parks or Areas of Outstanding Natural Beauty are affected by the proposal. In addition impacts on landscapes were scoped out of the EIA at the scoping stage.

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
SOC_07	Seascapes	Proposals should demonstrate how potential impacts on seascapes have been taken into consideration and should, in order of preference: a) avoid adverse impacts on seascapes; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Opportunities to enhance seascapes are encouraged.	Project will not impact on this policy.	Impacts on seascapes were scoped out of the EIA at the scoping stage (as the aggregate extraction work will only result in physical changes to the subtidal environment).
SOC_08	Resilience to coastal change and flooding	Proposals should demonstrate how they are resilient to coastal change and flooding over their lifetime.	Although the project will not directly impact this policy, it has the potential to support this policy.	Not applicable *per se*, as this is a sea-based activity only. It is worth noting that marine aggregates are often utilised for flood risk management purposes, notably beach nourishment and hard defence construction. The pathway 'potential for maintaining source of aggregate for coastal defences and beach nourishment' has subsequently been assessed in Section 15 of the ES as having a potentially minor beneficial impact.
SOC_09	Effects on coastal change and flooding	Proposals should demonstrate how they: avoid significant adverse impacts upon coastal processes; and minimise the risk of coastal change and flooding; Proposals that align with the relevant Shoreline Management Plan(s) and its policies are encouraged.	Project will comply with this policy.	Potential impacts on physical processes have been assessed in Section 5 of the ES (and the accompanying Coastal Impact Study (CIS)), and impacts on coastal protection and flood defence in Section 15 of the ES. The ES concluded that, impacts in relation to both receptors were not of a scale which would trigger the need for additional mitigation measures. Standard industry mitigation measures will be observed (see Section 3.5 of the ES for the existing best practice observed by the industry, and also the 2017 good practice guide published by BMAPA and The Crown Estate).
SOC_10	Minimising climate change	Proposals should demonstrate how they, in order of preference: a) avoid the emission of greenhouse gases; and/or b) minimise them where they cannot be avoided; and/or c) mitigate them where they cannot be minimised. Where significant emission of greenhouse gases cannot be avoided, minimised or mitigated, proposals for regulated activities must present a clear and convincing case for proceeding.	Project will conform to this policy and has the potential to result in a positive impact on this policy.	Carbon dioxide (CO_2) emissions in relation to aggregate production (vessels) have been discussed in Section 16 of the ES, with data presented demonstrating that dredger emissions have generally reduced in the recent past, a trend which is expected to continue.
SOC_11	Resilience to climate change	Proposals should demonstrate that they have considered the impacts of climate change and have incorporated appropriate adaptation measures, taking into account Climate Change Risk Assessments for Wales. Proposals that contribute to climate change adaptation and/or mitigation are encouraged.	Although the project will not directly impact this policy, it has the potential to support this policy.	Climate change scenarios have been considered when undertaking the CIS for the proposal; apart from this, as the proposals relate to a vessel only sea-based activity, whereby no new infrastructure is involved, this is not applicable to the proposals *per se*. as noted above, however, marine aggregates are often utilised for the maintenance and construction of coastal and flood protection defences required for climate change adaptation.
ENV_01	Resilient marine ecosystems	Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference: a) avoid adverse impacts; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.	Project will conform to this policy.	Potential impacts on marine ecosystems have been assessed in Sections 8 to 11 of the ES (benthic habitats and species; fish and shellfish; ornithology; and marine mammals and turtles). The ES concluded that, provided that the standard industry mitigation measures were adopted, impacts in relation to all receptors would be insignificant to minor adverse. Standard industry mitigation measures are summarised in Section 3.5 of the ES.
ENV_02	Marine Protected Areas	Proposals should demonstrate how they: avoid adverse impacts on individual Marine Protected Areas (MPAs) and the coherence of the network as a whole; have regard to the measures to manage MPAs; and avoid adverse impacts on designated sites that are not part of the MPA network.	Project will comply with this policy.	Potential impacts on MPAs have been assessed in Section 7 of the ES, and a separate Appropriate Assessment Signposting Document included as Appendix C. Bedwyn Sands and NMG directly overlaps with the Severn Estuary Special Area of Conservation (SAC), Severn Estuary Special Protection Area (SPA) and Severn Estuary Ramsar site. The HRA's initial conclusions on the favourable condition targets of the designated features suggest that there should be no failures of targets given the predicted scale of change.
ENV_03	Invasive non-native species	Proposals should demonstrate how they avoid or minimise the risk of introducing and spreading invasive non-native species. Where appropriate, proposals should include biosecurity measures to reduce the risk of introducing and spreading of invasive non-native species.	Project will comply with this policy.	The risk of introducing and spreading invasive non-native species assessed in Section 8 of the ES. In order to manage potential non-native species risks during aggregate extraction, a Biosecurity Plan will be produced in accordance with best practice guidance (this is proposed for the pre-dredge phase, should a licence be granted).
ENV_04	Marine litter	Proposals should demonstrate how they: avoid the deliberate introduction of litter into the marine plan area; and minimise the risk of accidental release of litter.	Project will comply with this policy.	Whilst not assessed in the ES, the industry best practice is being observed by the Breedon Group.
ENV_05	Underwater noise	Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: a) avoid adverse impacts; and/or b) minimise impacts where they cannot be avoided; and/or c) mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	Project will comply with this policy.	Underwater noise impacts from the dredging vessels on benthic receptors have been assessed in Section 8.3 of the ES; on fish in Section 9.3, and on marine mammals in Section 11.3. In all cases, impacts have been assessed as insignificant, with no mitigating actions considered to be required.
ENV_06	Air and water quality	Proposals should demonstrate that they have considered their potential air and water quality impacts and should, in order of preference: a) avoid adverse impacts; and/or b) minimise adverse impacts where they cannot be avoided; and/or c) mitigate adverse impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or	Project will comply with this policy.	Air and water quality impacts have been assessed in Sections 16 and 6 of the ES respectively. Impacts have been assessed as insignificant in both cases, with no mitigating actions considered to be required.

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
		mitigated, proposals must present a clear and convincing case for proceeding.		
ENV_07	Fish species and habitats	Proposals potentially affecting important feeding, breeding (including spawning & nursery) and migration areas or habitats for key fish and shellfish species of commercial or ecological importance should demonstrate how they, in order of preference: a) avoid adverse impacts on those areas; and/or b) minimise adverse impacts where they cannot be avoided; and/or c) mitigate adverse impacts where they cannot be minimised; If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	Project will comply with this policy.	Impacts on fish (and their habitats) have been assessed in Sections 9 of the ES. Impacts have been assessed as insignificant to minor adverse at worst (for direct removal of sandeel/entrainment by the dredger draghead), and no mitigation measures over and above established industry measures are considered to be required.
GOV_01	Cumulative effects	Proposals should demonstrate that they have assessed potential cumulative effects and should, in order of preference: a) avoid adverse effects; and/or b) minimise effects where they cannot be avoided; and/or c) mitigate effects where they cannot be minimised. If significant adverse effects cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to positive cumulative effects are encouraged.	Project will comply with this policy.	Cumulative and In-combination Effects have been assessed in Section 19 of the ES. This concluded that the proposed aggregate extraction will not substantially change the current baseline, particularly given the proposed activity is already undertaken, and the cumulative/in combination effects are very small in relation to the wider study area, especially when considered against the scale of other activities and plans. The occurrence of significant adverse cumulative/in-combination effects is therefore considered unlikely, though uncertainty remains due to the relatively limited information available on some future projects.
GOV_02	Cross-border and plan compatibility	Relevant public authorities, in making their decisions, should have regard to: any applicable policy in a relevant marine plan; any applicable policy in relevant terrestrial development plans or related documents; the Natural Resources Policy; any relevant local well-being plan(s) (including the local well-being assessment); and evidence in any relevant Area Statement(s) produced by Natural Resources Wales (NRW).	Policy is not applicable to the applicant for the project.	With regard to cross-border compatibility, as the Renewal Areas straddle the Welsh/English border, all relevant English plans have also been considered for the purpose of the application, in addition to those applicable to Wales (see the introduction to this Appendix and Appendix B of the ES). This policy is directed towards public authorities and is therefore not directly applicable to the applicant.
SCI_01	Using sound science responsibly	Relevant public authorities should make decisions using sound evidence and a risk-based, proportionate approach. Where appropriate they should apply the precautionary principle and consider opportunities to apply adaptive management.	Policy is not applicable to the applicant for the project.	This policy is directed towards public authorities to encourage the use of sound evidence and a proportionate and risk-based approach to decision making and is therefore not applicable to the applicant.
AGG_01a	Aggregates (supporting)	Proposals for new aggregate extraction will be supported, within any tonnage limits, where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Project will comply with this policy.	This application is for the renewal of existing aggregate licence areas within the existing extraction limits. The proposals are considered to comply with the relevant policies and considerations of the WNMP as set out in this table.
AGG_01b	Aggregates (supporting)	Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities: for the sustainable use of wider marine aggregate natural resources; to define and, once in place, further develop and refine Strategic Resource Areas for aggregates in order to support the sustainable development of the aggregate sector through marine planning.	Policy is not applicable to the applicant for the project.	This policy is directed towards strategic resources areas and is therefore not applicable to the applicant.
AQU_01a	Aquaculture (supporting)	Proposals for new aquaculture developments will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
AQU_01b	Aquaculture (supporting)	Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities for the sustainable use of aquaculture resources including the identification of: natural resources that provide aquaculture potential opportunities to define and, once in place, further develop and refine Strategic Resource Areas for aquaculture in order to support the sustainable development of the aquaculture sector through marine planning.	Policy is not applicable to the applicant for the project.	Not applicable.
D&D_01	Dredging and disposal (supporting)	Proposals that maintain navigable channels and long term access to open at-sea disposal sites for appropriate material will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Project will comply with this policy.	The ongoing aggregate extraction at Bedwyn Sands and NMG will not result in significant cumulative and in-combination effects with other plans, projects and activities, including ongoing dredging and disposal activities, as detailed in Section 19 of the ES.
ELC_01a	Low carbon energy (supporting) wind	Proposals for offshore wind energy generation will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations. Proposals for wind >350 MW will be considered by UK Government in accordance with relevant national policy. In determining an NSIP for a wind proposal, the decision maker will have regard to this plan. Any determination in relation to energy	Policy is not applicable to the project.	Not applicable.

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
		developments of any scale will be taken in accordance with this plan alongside any other relevant considerations.		
ELC_01b	Low carbon energy (supporting) wind	In order to understand future opportunities for offshore wind development, including floating technologies, this plan supports strategic planning for the sector. Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities for the sustainable use of wind energy resources including identification of: • natural resources that provide potential opportunity for future use; • evidence to de-risk consenting for the sector; and • opportunities to define and, once in place, further develop and refine Strategic Resource Areas for offshore wind energy resource safeguarding; in order to support the sustainable development of the sector through marine planning. Relevant public authorities should make appropriate evidence available to support planning and decision making in order to support the sustainable development of the sector through marine planning, where it is appropriate to do so.	Policy is not applicable to the project.	Not applicable.
ELC_02a	Low carbon energy (supporting) wave	Proposals for wave energy generation will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
ELC_02b	Low carbon energy (supporting) wave	In order to understand future opportunities for wave energy development, relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities for the sustainable use of wave energy resources including identification of: • natural resources that provide potential opportunity for future use; • evidence to de-risk consenting for the sector; and • opportunities to define and, once in place, further develop and refine Strategic Resource Areas for wave energy resource safeguarding; in order to support the sustainable development of the sector through marine planning. Relevant public authorities should make appropriate evidence available to support planning and decision making in order to support the sustainable development of the sector through marine planning, where it is appropriate to do so.	Policy is not applicable to the project.	Not applicable.
ELC_03a	Low carbon energy (supporting) tidal stream	Proposals for tidal stream energy generation will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
ELC_03b	Low carbon energy (supporting) tidal stream	In order to understand future opportunities for tidal stream energy development, relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities for the sustainable use of tidal stream energy resources including identification of: • natural resources that provide potential opportunity for future use; • evidence to de-risk consenting for the sector; and • opportunities to define and, once in place, further develop and refine Strategic Resource Areas for tidal stream energy resource safeguarding; in order to support the sustainable development of the sector through marine planning. Relevant public authorities should make appropriate evidence available to support planning and decision making in order to support the sustainable development of the sector through marine planning, where it is appropriate to do so.	Policy is not applicable to the project.	Not applicable.
ELC_04	Low carbon energy (supporting) tidal range	In order to understand future opportunities for tidal range development, strategic planning for the sector is encouraged. Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to: • collect evidence to support understanding of environmental constraints and opportunities for the sustainable use of the tidal range resource; • support understanding of the optimal siting of tidal lagoon developments across Wales as part of a wider, UK perspective; and • identify opportunities to define and, once in place, further develop and refine Strategic Resource Areas for tidal lagoon safeguarding purposes. Relevant public authorities should make appropriate evidence available to support planning and decision making in order to support the sustainable	Policy is not applicable to the project.	Not applicable.

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
		development of the sector through marine planning, where it is appropriate to do so.		
O&G_01a	Oil and gas (supporting)	Proposals that maximise the economic recovery of oil and gas sustainably will be supported where they comply with the objectives of this plan, and fully meet the environmental safeguards contained within the statutory processes of awarding production licences and subsequent activity-specific approvals. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
O&G_01b	Oil and gas (supporting)	Welsh Government policy is to avoid the continued extraction of fossil fuels in intertidal areas and estuaries and coastal inlet waters that fall within the Welsh onshore licence area. Applications for new petroleum licenses in these areas should not be supported, unless required for mine safety or scientific purposes. Proposals for the development and extraction of oil and gas in these areas with land based elements must provide robust and credible evidence to demonstrate how they conform to the Planning Policy Wales Energy Hierarchy for Planning, including how they make a necessary contribution towards decarbonising the energy system.	Policy is not applicable to the project.	Not applicable.
O&G_02	Oil and gas (supporting)	Proposals that support the long-term development of carbon capture and storage technology will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
FIS_01a	Fisheries (supporting)	Proposals that support and enhance sustainable fishing activities will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
FIS_01b	Fisheries (supporting)	Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities to develop a strategic evidence base to improve understanding of opportunities for the sustainable development of fisheries in order to support the sustainable development of the fisheries sector through marine planning.	Policy is not applicable to the project.	Not applicable.
P&S_01a	Ports and shipping (supporting)	Proposals for ports, harbours and shipping activities will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
P&S_01b	Ports and shipping (supporting)	Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities to support the sustainable development of the ports and shipping sector through marine planning.	Policy is not applicable to the project.	Not applicable.
P&S_02	Ports and shipping (supporting)	Proposals that provide for the maintenance, repair, development and diversification of port and harbour facilities will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
CAB_01	Subsea cabling (supporting)	Proposals that facilitate the growth of digital communications networks and/or the optimal distribution of electricity will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
T&R_01a	Tourism and recreation (supporting)	Proposals that demonstrate a positive contribution to tourism and recreation opportunities and policy objectives (for the sector) around the Welsh coast will be supported where they contribute to the objectives of this plan. Proposals should comply with the relevant general policies and sector safeguarding policies of this plan and any other relevant considerations.	Policy is not applicable to the project.	Not applicable.
T&R_01b	Tourism and recreation (supporting)	Relevant public authorities and the sector are encouraged, in liaison with other interested parties, to collaborate to understand opportunities for sustainable tourism and recreation around the Welsh coast, including: a) developing a strategic evidence base to improve understanding of current and potential tourism and recreation activities, including eco-tourism and	Policy is not applicable to the project.	Not applicable.

WNMP Policy No.	WNMP Policy		Does the Project Have the Potential to Impact the Policy?	How Does the Proposed Project Comply with the Policy?
		other low impact activities; and b) opportunities to define areas of future opportunity for tourism and recreation; in order to support the sustainable development of the tourism and recreation sector through marine planning.		
SAF_01	Safeguarding existing activity	a: Proposals likely to have significant adverse impacts upon an established activity covered by a formal application or authorisation must demonstrate how they will address compatibility issues with that activity. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for the proposal to progress under exceptional circumstances. b: Proposals likely to have significant adverse impacts upon an established activity not subject to a formal authorisation must demonstrate how they will address compatibility issues with that activity. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for proceeding. Under SAF 01 a and b, compatibility should be demonstrated through, in order of preference: a. Avoiding significant adverse impacts on those activities, and/or b. Minimising significant adverse impacts where these cannot be avoided; and/or c. Mitigating significant adverse impacts where they cannot be minimised.	Policy is not applicable to the project.	Not applicable.
SAF_02	Safeguarding strategic resources	Proposals which may have significant adverse impacts upon the prospects of any sector covered by this plan to engage in sustainable future strategic resource use (of resources identified by an SRA) must demonstrate how they will address compatibility issues with that potential resource use. Proposals unable to demonstrate adequate compatibility must present a clear and convincing case for proceeding. Compatibility should be demonstrated through, in order of preference: a. Avoiding significant adverse impacts on this potential strategic resource use, and/or b. Minimising significant adverse impacts where these cannot be avoided; and/or c. Mitigating significant adverse impacts where they cannot be minimised.	Policy is not applicable to the project.	Not applicable.
DEF_01	Defence (safeguarding)	Proposals that: • potentially affect Ministry of Defence (MOD) Danger Areas, Exercise Areas or strategic defence interests; and/or • potentially interfere with communication, surveillance and navigation facilities necessary for defence and national security; should only be authorised with the agreement of MOD.	Policy is not applicable to the project.	Not applicable.

E.3 References

British Marine Aggregate Producers Association (BMAPA), 2012. 'Guide To Good Practice For Ensuring Navigation Safety During Aggregate Dredging Operations'. September 2012

BMAPA and The Crown Estate (2017). Good Practice Guidance Extraction by Dredging of Aggregates from England's Seabed April 2017.

Welsh Government (2019). Welsh National Marine Plan [Online] Available at: https://www.gov.wales/welsh-national-marine-plan [Accessed 13/09/2023]

F Marine Archaeology Desk Based Assessment

Bedwyn Sands and North Middle Grounds

Marine Archaeology Desk-Based Assessment

Ref: 265480.01
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wessexarchaeology

Report Information

Document title	Bedwyn Sands and North Middle Grounds
Document subtitle	Marine Archaeology Desk-based Assessment
Document reference	265480.01
Client name	ABP Marine Environment Research Ltd.
Address	Quayside Suite Medina Chambers Town Quay Southampton, Hampshire SO14 2AQ
On behalf of	Severn Sands Holdings Ltd.
Site location	Severn Estuary – Bedwyn Sands and North Middle Ground (Area 455 and 459)
County	N/A
National grid reference	ST 38688 78573; ST 47783 82581
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Planning reference	EIA/2022/00044
Museum name	N/A
Museum accession code	N/A
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Project management by	Andrea Hamel
Document compiled by	Stephanie Said
Contributions from	
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Quality Assurance

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Summary

Wessex Archaeology was commissioned by ABPmer to prepare an archaeological desk-based assessment that will in turn inform an Environmental Statement chapter for marine aggregates Bedwyn Sands and North Middle Ground Areas 455 and 459. The areas are located within the Upper Severn Estuary within Welsh and English territorial waters.

Documentary evidence has been assessed to verify the location and condition of the known and potential archaeological resource within Licence Areas Bedwyn Sands and North Middle Ground, 455 and 459, with regards to seabed prehistory and maritime and aviation archaeology. A discussion on the historic seascape character has also been undertaken for the area.

The assessment has established that there are the following marine archaeological assets:

- the potential for organic deposits containing material of palaeoenvironmental interest within the study area;
- one recorded wreck site within the study area;
- no known aircraft crash sites;
- potential for additional currently unknown maritime and aviation seabed features to exist; and
- the Historic Seascape Character of the area comprising: navigational activity and hazards; shipping activity; extractive industry (minerals); and cultural topography (marine).

There is potential for the proposed activities to impact as yet unknown archaeological sites related to seabed prehistory, shipwrecks and aircraft crash sites.

The key mitigation to reduce the significance of effects with regard to the loss of archaeological material within the volume of aggregate, and to deal with new discoveries once they occur, is the existing Marine Aggregate Industry Protocol for reporting finds of archaeological interest, including the provision for Temporary Exclusion Zones (TEZs) should archaeological material of importance be discovered during dredging works. Additional mitigation could include the implementation of Archaeological Exclusion Zones (AEZs) to prevent direct impacts to known archaeological receptors. Preservation by record and archaeological watching briefs are also methods of offsetting and reducing disturbance to sites.

Acknowledgements

This project was commissioned by ABPmer on behalf of Severn Sands Holdings Ltd. and Wessex Archaeology is grateful to staff for their assistance.

Data was provided by the United Kingdom Hydrographic Office (UKHO), the National Marine Heritage Record (NMHR), National Monuments Record of Wales (NMRW), and Glamorgan-Gwent Archaeological Trust (GGAT) Historic Environment Records (HERs). Wessex Archaeology is grateful to the staff of all the above organisations for their cooperation during the project.

The report was researched and compiled by Stephanie Said. Kitty Foster prepared the illustrations. Andrea Hamel managed the project on behalf of Wessex Archaeology.

Bedwyn Sands and North Middle Grounds

Marine Archaeology Desk-based Assessment

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by ABP Marine Environment Research Ltd. on behalf of Severn Sands Holdings Ltd. to prepare a marine archaeology desk-based assessment for marine aggregate dredging at Bedwyn Sands and North Middle Ground (NMG) Areas 455 and 459 in the Severn Estuary. The assessment has in turn informed the Environment Statement (ES).

1.1.2 Bedwyn Sands lies largely within Welsh territorial waters, with the southern quarter extending into English territorial waters. NMG Areas lie entirely within Welsh territorial waters (Figure 1). The two sites are centred on national grid reference ST 38688 78573 and ST 47783 82581, respectively.

1.2 Development proposal

1.2.1 Severn Sands Holdings Ltd. is proposing to renew permission to dredge aggregates from Bedwyn Sands and NMG Areas in the Severn Estuary. Under the Marine and Coastal Act 2009 a marine licence is required from the marine licensing authorities, Natural Resource Wales (NRW) and Marine Management Organisation (MMO).

1.2.2 Severn Sands Holdings Ltd. is seeking to continue undertaking dredging through trailer suction hopper dredger (THSD) within Bedwyn Sands and NMG Areas. The technique of TSHD is a common method of extracting marine aggregates, with penetration depths typically reaching up to 0.5 m deep. The current work is expected to involve the dredging of approximately 3,750,000 m^3 of material from Bedwyn Sands and NMG Areas, respectively (ABPmer 2022b).

1.3 Previous impact

1.3.1 Licenced aggregate extraction activities from Bedwyn Sands and NMG Areas have been carried out since 2008 and 2011, respectively. The marine licences for both sites were renewed in 2017 for a seven-year period (MMML 1605), with an expiration date of 2024.

1.3.2 Monitoring survey works have been undertaken at Bedwyn Sands and NMG Areas since 2008, in line with previous Marine Licence renewal conditions. These consisted of bathymetric and topographic monitoring, grab sampling and benthic monitoring (ABPmer 2019 and 2022a).

1.3.3 No finds have been reported through British Marine Aggregate Producers Association (BMAPA) from Bedwyn Sands and NMG Areas during previous years of aggregate extraction.

1.3.4 A Marine Archaeology scoping report was submitted as part of the Scoping Report for the aggregate dredging licence renewal of Bedwyn Sands and NMG Areas (APBmer 2022b).

1.4 Scope of document

1.4.1 The purpose of this assessment is to determine, as far as is possible from existing information, the nature, extent and significance of the known and potential marine archaeological resource within the boundary of Bedwyn Sands and NMG Areas.

1.4.2 Planning Policy Wales (PPW) (Welsh Government 2021) states that 'the historic environment comprises all the surviving elements of previous human activity and illustrates how past generations have shaped the world around us. It is central to Wales's culture and its character, whilst contributing to our sense of place and identity. It enhances our quality of life, adds to regional and local distinctiveness and is an important economic and social asset.'

1.4.3 PPW (Welsh Government 2021) notes that 'the historic environment is made up of individual historic features which are collectively known as historic assets' including listed buildings, historic landscapes and archaeological remains.

1.4.4 PPW, Technical Advice Note 24: The Historic Environment (2017) provides guidance on how the planning system considers the historic environment during development plan preparation and decision making on planning and Listed Building applications. The policy defines the historic environment as 'all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and deliberately planted or managed' (2017: 6).

1.4.5 The historic environment, as defined in Annex 2 of the National Planning Policy Framework (NPPF; Ministry of Housing, Communities and Local Government 2021, 67) comprises 'all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora'.

1.4.6 The NPPF Annex 2 (ibid.) defines a heritage asset as 'a building monument, site, place, area, or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest. Heritage assets include designated heritage assets and assets identified by the local planning authority (including local listing)'.

1.5 Aims

1.5.1 The specific aim of this marine archaeology desk-based assessment is to characterise the known and potential archaeological baseline within Bedwyn Sands and NMG Areas to subsequently inform the Environment Impact Assessment (EIA) and production of the ES.

1.5.2 The objectives of the assessment are as follows:

- to provide details of relevant legislation, national and local planning policy, and best practice guidance;
- to outline the known and potential marine archaeological resource within the licence areas based on a review of existing information;
- to summarise the Historic Seascape Character for the area that the licence areas truncate;

- to assess the significance of the known and potential marine archaeological resource through weighted consideration of their valued components; and

- to recommend mitigation measures for any potential archaeological or cultural heritage assets newly identified within Bedwyn Sands and NMG Areas, including the addition of new Archaeological Exclusion Zones where necessary within the licence areas.

1.6 Copyright

1.6.1 This report may contain material that is non-Wessex Archaeology copyright (e.g. Ordnance Survey, British Geological Survey (BGS), Crown Copyright), or the intellectual property of third parties, which Wessex Archaeology are able to provide for limited reproduction under the terms of our own copyright licence, but for which copyright itself is non-transferable by Wessex Archaeology. Users remain bound by the conditions of the Copyright, Designs and Patents Act 1988 with regards to multiple copying and electronic dissemination of the report

2 LEGISLATION, GUIDANCE AND POLICY

2.1 Introduction

2.1.1 The licence areas fall within two national jurisdictions, each covered by separate legislation and guidance, and is under the responsibility of different curators and heritage agencies.

2.1.2 The following section provides a summary of the national, regional and local planning and legislative framework which governs the treatment of the marine historic environment in the planning process. More details are provided in Appendix 2.

2.2 International conventions

2.2.1 The UNESCO Convention was concluded in 2001 and is a comprehensive attempt to codify the law internationally with regards to underwater archaeological heritage. The UK (including the Bailiwick of Guernsey) abstained in the vote on the final draft of the Convention, however, it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. Although the UK is not a signatory, the Convention entered into force on 2nd January 2009 having been signed or ratified by 20 member states. To date, the Convention has been ratified by 72 countries.

2.2.2 The Annex of the convention suggests preservation in situ as best archaeological practise.

2.3 Marine legislation

Wales

2.3.1 Cadw is responsible for the archaeological resource within Wales's territorial waters, to the 12 nautical miles (nm) limit, while the main source of information on underwater heritage in Wales is the marine database of the National Monument Record compiled by the Royal Commission on Ancient and Historical Monuments in Wales (RCAHMW). NRW is responsible for licencing, regulating and planning marine activities in the seas around Wales to ensure they are carried out in a sustainable way.

2.3.2 The Historic Environment (Wales) Act 2016 is the fundamental statutory framework for the protection and management of the Welsh historic environment, along with the Ancient Monuments and Archaeological Areas Act 1970, the Planning Act 1990 and the Protection of Wrecks Act 1973.

2.3.3 The Welsh National Marine Plan identifies opportunities for the sustainable development of Wales's seas (Welsh Government 2019) by guiding new development and related decisions both inshore and offshore. Development plans and the Marine Plan should work together and support integrated decision making and collaboration across marine and terrestrial interfaces and boundaries (Welsh Government 2021).

2.3.4 The following relevant legislation applies within the Welsh sub-area of Bedwyn Sands and NMG Areas:

- Marine and Coastal Access Act 2009;
- Historic Environment (Wales) Act 2016;
- Protection of Wrecks Act 1973: Section One and Two;
- Ancient Monuments and Archaeological Areas Act 1979 (as amended);
- Protection of Military Remains Act 1986; and
- Merchant Shipping Act 1995.

England

2.3.5 Historic England (HE) is responsible for the archaeological resource within England's territorial waters, up to the 12 nm limit. The Marine Management Organisation (MMO) is responsible for licencing, regulating and planning marine activities in English territorial waters and also some activities beyond the territorial waters, to ensure they are carried out in a sustainable way.

2.3.6 The following relevant legislation applies within the English sub-area of Bedwyn Sands:

- Marine and Coastal Access Act 2009;
- Protection of Wrecks Act 1973: Section One and Two;
- Ancient Monuments and Archaeological Areas Act 1979 (as amended);
- Protection of Military Remains Act 1986; and
- Merchant Shipping Act 1995.

2.3.7 The above legislation provides a context for focussing approaches and consultation. These legal frameworks provide protection for marine historic assets of historical, archaeological or artistic value, as well as allowing military wrecks and aircraft remains to be protected. Ownership of any wreck remains is determined in accordance with the Merchant Shipping Act 1995 as administered by the Receiver of Wreck.

2.4 Marine policy

2.4.1 The Marine and Coastal Access Act (MCAA) 2009 received Royal Assent on 12 November 2009. It introduced new planning and management systems for overseeing the marine environment, most notably through the requirement to obtain marine licences for works at sea (including the deposition or removal of any substance or object from the sea below Mean High Water). It created a strategic marine planning system that seeks to promote the efficient, sustainable use and protection of the marine environment, guided by the Marine Policy Statement (MPS) and a series of Marine Plans.

2.4.2 Marine plans must be consistent with the MPS (Defra 2011) and fully reflect the requirements of the MPS at a local level. Marine plans must also be in accordance with other UK national policy, including Planning Policy Wales (PPW) (Welsh Government 2021) and the National Planning Policy Framework (NPPF) (DCLG 2012).

Planning Policy Wales

2.4.3 PPW (Welsh Government 2021) sets out the land use planning policies of the Welsh Government. It describes the planning system as managing the use of land in the public interest, and states that the system 'must reconcile the needs of development and conservation […] and protecting, promoting, conserving and enhancing the built and historic environment'. The importance of the historic environment in Welsh planning policy is interwoven throughout the document.

2.4.4 The section on 'Distinctive & Natural Places' states that 'The historic environment is a finite, non-renewable and shared resource and a vital and integral part of the historical and cultural identity of Wales […] The historic environment can only be maintained as a resource for future generations if the individual historic assets are protected and conserved.'

2.4.5 The Welsh Government's specific objectives for the historic environment include conserving archaeological remains, both for their own sake and for their role in education, leisure and the economy.

2.4.6 The Planning Policy notes that the conservation and enhancement of historic assets is most effective when considered at the earliest stage of plan preparation or when designing new proposals.

2.4.7 It also states that 'any decisions made through the planning system must fully consider the impact on the historic environment and on the significance and heritage values of individual historic assets and their contribution to the character of place.'

Welsh National Marine Plan

2.4.8 The Welsh National Marine Plan (2019) is the first marine plan for Wales and is intended to guide the sustainable development of the marine area by setting out how proposals will be considered by decision makers.

- SOC_04 Welsh language and culture – proposals that contribute to the promotion and facilitation of the use of the Welsh language and culture are encouraged. This policy seeks to ensure that all developers consider their impact on Welsh Culture, including heritage and the historic environment;

- SOC_05: Historic assets – proposals should demonstrate how potential impacts on historic assets and their setting have been taken into consideration and should, in order of preference:

    - Avoid adverse impacts on historic assets and their settings; and/or
    - Minimise impacts where they cannot be avoided; and/or
    - Mitigate impacts where they cannot be minimised.

- If significant adverse impacts cannot be avoided, minimised or mitigated proposals must present a clear and convincing case for proceeding.

Future Wales - The National Plan 2040

2.4.9 Future Wales - The National Plan 2040 (2021b) sets out the national development framework. It provides a development plan with a strategy for addressing key national priorities through the planning system. It recognises that landscape and heritage are key motivators for people to visit Wales.

National planning policy framework (NPPF)

2.4.10 The NPPF was first published by the Department for Communities and Local Government in March 2012, replacing Planning Policy Statement 5. The most recent iteration of the NPPF, published by the Ministry of Housing, Communities and Local Government, was released in July 2021.

2.4.11 Section 16 of the NPPF, Conserving and enhancing the historic environment, sets out the principal national guidance on the importance, management and safeguarding of heritage assets within the planning process. The aim of this section is to ensure that Regional Planning Bodies and Local Planning Authorities, developers and owners of heritage assets adopt a consistent and holistic approach to their conservation and to reduce complexity in planning policy relating to proposals that affect them.

2.4.12 The government guidance provides a framework that:

- recognises that heritage assets are an irreplaceable resource;
- requires applicants to provide proportionate information on the significance of heritage assets affected by the proposals and an impact assessment of the proposals on that significance;
- takes into account the desirability of sustaining and enhancing the significance of heritage assets and their setting;
- places weight on the conservation of designated heritage assets;
- requires developers to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and impact, and to make this evidence (and any archive generated) publicly accessible; and
- promotes the conservation of heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations.

South West Inshore Marine Plan

2.4.13 Under the MCAA 2009 the UK was divided into marine planning regions, with an associated planning authority responsible for preparing a marine plan for that area. The MPS (Department for Environment, Food and Rural Affairs 2011) sets out the framework for preparing Marine Plans and taking decisions affecting the marine environment and was jointly adopted by the Secretary of State, Scottish Ministers, Welsh Ministers, and the Department of the Environment in Northern Ireland in 2011.

2.4.14 The UK MPS notes that 'marine activities have the potential to result in adverse effects on the historic environment both directly and indirectly, including damage to or destruction of heritage assets' (Department for Environment, Food and Rural Affairs 2011, 22).

2.4.15 In England, the MMO have divided the inshore and offshore waters into 11 plan areas for which marine plans are to be produced. The English sub-area of Bedwyn Sands is located within the South West Inshore Marine Plan.

2.4.16 The South West Inshore and South West Offshore Marine Plan was published in June 2021 (Department for Environment, Food and Rural Affair 2021). This states (SW-HER-1) that proposal unable to conserve and enhance elements contributing to the significance of heritage assets must demonstrate that they will, in order of preference:

- Avoid;
- Minimise; and
- Mitigate any harm to the significance of heritage assets.

2.4.17 If it is not possible to mitigate, then public benefits for proceeding with the proposal must outweigh the harm to the significance of heritage assets.

2.5 Marine guidance

2.5.1 This assessment was carried out in a manner consistent with available guidance as described below in chronological order of issue:

- Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers (English Heritage 1998);
- Managing Lithic Scatters: Archaeological Guidance for Planning Authorities and Developers (English Heritage 2000);
- Military Aircraft Crash Sites: Archaeological guidance on their significance and future management (English Heritage 2002);
- Marine Aggregate Dredging and the Historic Environment. Assessing, evaluation, mitigation and monitoring the archaeological effects of marine aggregate dredging: Guidance note (BMAPA and English Heritage 2003);
- Protocol for reporting finds of archaeological interest (BMAPA and English Heritage 2005);
- The Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee and The Crown Estate 2006);
- Our Seas – A shared resource: High level marine objectives (Defra 2009);
- Cadw, Caring for Military Sites of the Twentieth Century (2009);
- Cadw, Conservation Principles for the Sustainable Management of the Historic Environment in Wales (2011);

- Environmental Archaeology: A Guide to the Theory and Practice of Methods, from Sampling and Recovery to Post-excavation (second edition) (English Heritage 2011);
- Ships and Boats: Prehistory to Present - Designation Selection Guide (English Heritage 2012);
- Managing Significance in Decision-Taking in the Historic Environment Historic Environment Good Practice Advice in Planning: 2 (Historic England 2015);
- Preserving Archaeological Remains: Decision-taking for Sites under Development (Historic England 2016);
- Cadw, Setting of Historic Assets in Wales (2017);
- Conservation Principles for the Sustainable Management of the Historic Environment (Historic England 2017);
- Statements of Heritage Significance: Analysing Significance in Heritage Assets: Historic England Advice Note 12 (Historic England 2019);
- Managing the Marine Historic Environment of Wales (Annex B – Draft) (Natural Resources Wales in conjunction with Cadw & Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW, March 2019);
- Cadw, Managing the Marine Historic Environment of Wales (2020);
- Deposit Modelling and Archaeology Guidance for Mapping Buried Deposits (Historic England 2020);
- Standard and Guidance for Archaeological Advice by Historic Environment Services (Chartered Institute for Archaeologists 2020a);
- Standard and guidance for historic environment desk-based assessment (Chartered Institute for Archaeologists 2020b);
- Code of Conduct: Professional Ethics in Archaeology (Chartered Institute for Archaeologists 2022);
- Curating the Palaeolithic (Historic England 2023); and
- Marine Character Areas (MCA 29 Severn Estuary) (National Resources Wales 2015).

3 METHODOLOGY

3.1 Study area

3.1.1 The area assessed in this report is defined by the licence area extents as provided by the client, which is located within Welsh and English territorial waters (Figure 1).

3.1.2 The assessment also considered the wider Severn Estuary to allow for a greater understanding of the wider archaeological baseline environment, with the dual purpose of enabling any archaeological trends within the region to be recognised and to allow any marine archaeology and cultural heritage assets identified to be represented in a broader archaeological context.

3.2 Archaeological desk-based assessment

Key themes

3.2.1 The methodology follows the best practice professional guidance outlined by the Chartered Institute for Archaeologists' (CIfA) Standard and Guidance for Historic Environment Desk-Based Assessment (2014, updated 2020).

3.2.2 The marine themes relevant to marine archaeological baseline as assessed in this report are:

- Seabed prehistory (for example, palaeochannels and other features that contain prehistoric sediment, and derived Palaeolithic artefacts e.g. handaxes);
- Seabed features, including maritime sites (such as shipwrecks and associated material including cargo, obstructions and fishermen's fasteners) and aviation sites (aircraft crash sites and associated debris); and
- Historic Seascape Character.

Data sources

3.2.3 Baseline conditions have been established by undertaking a desktop review of published information and through consultation with relevant organisations. The data sources used to inform the baseline description and assessment include:

- United Kingdom Hydrographic Office (UKHO) data for charted wrecks and obstructions;
- National Heritage List maintained by Cadw comprising data of designated heritage assets including sites protected under the Protection of Military Remains Act 1986 and the Protection of Wrecks Act 1973;
- National Marine Heritage Record (NMHR) maintained by Historic England, comprising data for marine archaeological sites;
- National Monuments Record of Wales (NMRW) maintained by Coflein and derived from information by Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW), comprising data for terrestrial and marine archaeological sites, find spots and archaeological events;
- the relevant Historic Environment Record(s) (HER) particularly from Glamorgan-Gwent Archaeological Trust (GGAT);
- datasets comprising the Historic Seascape Characterisation (HSC): Consolidating the National HSC Database (LUC 2017) and Marine Character Area for Severn Estuary (NRW 2015b);
- records from isolated finds from the Severn Estuary, including those reported through BMAPA Protocol;

- background geological data for the area produced by the British Geological Survey (BGS), historical maps, Ordnance Survey maps and Admiralty Charts;

- previous work undertaken in the Severn Estuary and Bristol Channel regions by Wessex Archaeology; and,

- relevant primary and secondary documentary sources and grey literature held by Wessex Archaeology, and those available through the Archaeological Data Service and other websites.

Data structure

3.2.4 In order to compile the marine archaeological baseline as presented in this report, where possible, the sources were incorporated into a project Geographic Information System (GIS) using ArcGIS 10.8, enabling the data to be spatially analysed.

3.2.5 The NMRW and HER records have been discriminated between records for which there is known material on the seabed and 'recorded losses' (vessels and aircraft that are known to have been lost, but do not, except by chance, have material on the seabed at their recorded loss location). The records with known material on the seabed are included in the 'wrecks and obstructions' gazetteer along with data from the UKHO (Appendix 3). The recorded losses are presented separately and have been used to assess the potential for further discoveries.

3.2.6 For the purposes of this report, the gazetteers are compiled and illustrated in British National Grid (BNG). Information relating to the archaeological and cultural heritage that did not include location or positional information were used to inform the marine archaeological baseline assessment where relevant.

3.2.7 For archaeological sites that were recorded in the UKHO, RCAHMW and HER datasets, the co-ordinates from the UKHO are the ones used in the gazetteer and GIS. As these relate to survey co-ordinates, they have been assessed as likely to be more accurate.

Chronology

3.2.8 Archaeological material is generally studied within a framework of 'periods' or 'ages' that reflect the activities and cultural changes taking place over time. All dates are referred to as BC (before Christ), BP (before present) or AD (anno domini) within the text. By convention, BC refers to calibrated radiocarbon chronology that can be considered equivalent to calendar years. BP dates are used for periods of time older than c.10,000 years ago.

3.2.9 A list of the main archaeological periods in Britain referred to in the text, along with their broadly defined dates, are presented in Appendix 1.

Seabed prehistory

3.2.10 The baseline assessment for palaeogeography was based on a range of secondary sources, including academic papers, monographs, geological information (e.g. BGS mapping), and previous work undertaken by Wessex Archaeology within the Severn Estuary area and the wider region. This baseline for the palaeogeographic assessment aids in producing a stratigraphy for the study area, assigning archaeological potential to identified units, and informing future sampling strategies.

Seabed features: maritime and aviation sites

3.2.11 The baseline summary for maritime and aviation archaeology was assessed by means of accessing any records of sites, findspots, wrecks, casualties and seabed features obtained from the UKHO, RCAHMW and HERs within the study area. The baseline assessment of maritime and aviation archaeology was further supplemented by a review of relevant primary and secondary source material in order to provide an indication on the nature of maritime and aviation activity across the region. As well as summarising the known archaeological resource, the baseline assessment underlines the potential for encountering unknown shipwreck and aircraft crash sites within the study area.

3.2.12 The data obtained were reviewed and those located within the study area were extracted and compiled to form a gazetteer of the known seabed features. These records were each given a unique identifier beginning with 2001 and continuing sequentially (Appendix 3) and were added to the project GIS.

3.2.13 Data relating to Recorded Losses were also extracted from the RCAHMW and NMHR and HER data sources. Recorded Losses are records for ships or aircraft that are known to have wrecked or crashed offshore, but for which the exact locations are not known. The positional data of these records is unreliable and serves only to provide an indication of the types of vessels that passed through the area and the wrecking incidents that are known to have occurred in the general region. Whilst the remains of these vessels and aircraft are expected to exist somewhere on the seafloor, their location is unknown. As such, they signify the potential maritime and aviation resource.

3.2.14 Details regarding Recorded Losses, whose Named Location happens to be located within the study area, are presented separately (Appendix 4). These records have retained their original identification assigned by the RCAHMW, NMHR and HER for ease of cross-referencing. The gazetteer does not include positional data due to the inherent inaccuracies therein.

Historic seascape characterisation

3.2.15 The baseline summary for character of the historic seascape within the study area was assessed using the results of National Seascape Assessment for Wales 2015 and the combined results of LUC’s Historic Seascape Characterisation (HSC): Consolidating the National HSC Database (2017). In particular, the assessment focussed on the Marine Character Areas for Severn Estuary (MCA 29) using the report and data sheets assessing Welsh seascapes and their sensitivity to offshore developments (Natural Resources Wales 2015b).

3.3 Assessment of Setting

3.3.1 PPW (2021b) states that “It is important that the planning system looks to protect, conserve and enhance the significance of historic assets. This will include consideration of the setting of an historic asset which might extend beyond its curtilage. Any change that impacts on an historic asset or its setting should be managed in a sensitive and sustainable way. It is the responsibility of all those with an interest in the planning system, including planning authorities, applicants, developers and communities, to appropriately care for the historic environment in their area. The protection, conservation and enhancement of historic assets is most effective when it is considered at the earliest stage of plan preparation or when designing new proposals.”

3.3.2 Currently, there is no specific guidance regarding the assessment of setting for offshore archaeological and cultural heritage assets. However, Cadw’s Setting of Historic Assets in

Wales (2017) provides general guidance, largely applicable to terrestrial sites, and notes that the importance of setting 'lies in what it contributes to the significance of a historic asset' (Cadw, 2017: 3). With regards to significance for heritage policy, the National Planning Policy Framework (NPPF) notes that the interest of a heritage asset 'may be archaeological, architectural, artistic or historic' (DCLG, 2012).

3.3.3 Cadw states that 'The setting of a historic asset includes the surroundings in which it is understood, experienced and appreciated, embracing present and past relationships to the surrounding landscape. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive, negative or neutral contribution to the significance of an asset.' (Cadw, 2017: 2).

3.3.4 The setting of a historic asset can include physical elements of its surroundings as well as less tangible elements. Although views to and from a historic asset are often the most obvious factors, other sensory elements can also affect setting (ibid.). Reference in the guidance is also made to the setting associated with buried heritage assets which may not be readily appreciated by a casual observer, but retains a presence in the landscape such as, for example, wreck sites that are periodically, partly or wholly submerged (ibid.: 2).

3.3.5 Cadw's Managing the Marine Historic Environment of Wales (2020) states that 'Development and use of the marine environment can, however, affect historic assets both directly and indirectly, including: loss of, or damage to, historic material; alteration to the setting of historic assets which can positively or negatively affect the ability to understand and appreciate them or through burial or exposure.'

3.3.6 Policy SOC_05 in the Welsh National Marine Plan (2019) states that "Proposals should demonstrate how potential impacts on historic assets and their settings have been taken into consideration and should, in order of preference:

a) avoid adverse impacts on historic assets and their settings; and/or

b) minimise impacts where they cannot be avoided; and/or

c) mitigate impacts where they cannot be minimised.

3.3.7 In order to assess whether, how and to what degree setting makes a contribution to the significance of heritage assets, the following must be considered: the physical surroundings of the asset including its relationship with other heritage assets; the way the asset is appreciated, and the asset's associations and patterns of use.

3.3.8 The assessment of setting in this document follows the guidance discussed in the paragraphs above, and draws on the results from the archaeological assessment of the marine heritage assets located within the study area. This is described using the following two factors:

- Physical surroundings and Views – which includes the physical presence of the asset on the seabed, its surroundings, and relationship with other assets and navigational hazards in the immediate area. Views to and from the asset, and how the asset is experienced in its immediate physical surroundings are also considered; and;

- Non-visual factors – including the way the asset is appreciated in a broader historical, artistic and intellectual capacity, and the asset's associations.

3.3.9 It should be noted that for heritage assets offshore, sites are generally only experienced by divers, remotely operated vehicle (ROV), or by geophysical survey, and the views to the asset are often very limited due to reduced visibility in the water column. In addition, unlike many terrestrial sites, the position of the asset on the seabed has not been deliberately chosen, and although some sites may have reached their position through military action (e.g. wartime losses and losses from mine-laying activity) (Natural Resources Wales 2015b) or have been lost due to a particular navigational hazard (e.g. hitting a harbour wall or being stranded on a particular sandbank for instance Bedwin Sands), many positions are entirely arbitrary, and even with military sinking events, an attack on the surface could lead to a wreck being deposited on the seabed miles from where the event took place. Non-visual factors may include associations with particular battles, wars, minefields, and other historic events, as well as how the wreck can be appreciated in its wider context, for example through well-known trade routes, collisions or local industry. Association between the asset and the local social history is another important aspect of an asset's non-visual importance, including rescue attempts or losses occurring within modern memory.

3.3.10 It is not possible to ascertain the setting of currently unidentified marine heritage assets, where limited information is known, for example unknown wrecks or wrecks that have not been characterised to determine their period of build, use or loss. Similarly, setting cannot be assessed for potential sites that have not yet been discovered.

3.4 Determining value and sensitivity

3.4.1 This report will adopt the conceptual approach known as the 'source-pathway-receptor' model. This approach is based on the identification of the source (i.e. the origin of a potential impact), the pathway (i.e. the means by which the effect of the activity could impact a receptor) and the receptor that may be impacted (e.g. known/ potential heritage assets). In order for the significance of any given impact to be fully understood, the sensitivity of any receptors that may be impacted need to be considered. This section outlines the means by which the sensitivity of marine heritage assets is ascertained.

3.5 Impact assessment criteria

Asset sensitivity

3.5.1 The capability of a receptor to accommodate change and its ability to recover if affected is a function of its sensitivity. Receptor sensitivity is typically assessed via the following factors:

- adaptability – the degree to which a receptor can avoid or adapt to an effect;
- tolerance – the ability of a receptor to accommodate temporary or permanent change without significant adverse impact;
- recoverability – the temporal scale over and extent to which a receptor will recover following an effect; and
- value – a measure of the receptor's importance, rarity and worth.

3.5.2 Marine heritage assets cannot typically adapt, tolerate or recover from physical impacts resulting in material damage or loss caused by project activities. Consequently, the sensitivity of each asset is predominantly quantified only by its value. The UK MPS (Department for Environment, Food and Rural Affairs 2011) describes a heritage asset as holding a degree of significance. Significance is the value of a heritage asset to this and future generations because of its heritage interest, which may be archaeological, architectural, artistic, or historic.

Value of an asset

3.5.3 Within this assessment, significance is weighed by consideration of the potential for the asset to demonstrate the following value criteria:

- evidential value - deriving from the potential of a place to yield evidence about past human activity;
- historical value - deriving from the ways in which past people, events and aspects of life can be connected through a place to the present. It tends to be illustrative or associative;
- aesthetic value - deriving from the ways in which people draw sensory and intellectual stimulation from a place; and
- communal value - deriving from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical (particularly associative) and aesthetic values but tend to have additional and specific aspects.

3.5.4 With regards to appraising the value of shipwrecks, the following criteria listed in English Heritage's Ships and Boats: Prehistory to Present - Designation Selection Guide (English Heritage (now Historic England), 2012) can be used to assess an asset in terms of its value:

- Period; Rarity; Documentation; Group value; Survival/condition; and Potential.

3.5.5 These aspects help to characterise each asset whilst also comparing them to other similar assets. The criteria also enable the potential to contribute to knowledge, understanding and outreach to be assessed.

3.5.6 The value of known archaeological and cultural heritage assets was assessed on a four-point scale using professional judgement informed by the criteria provided in Table 1**.**

Table 1 Criteria to assess the archaeological value of marine assets

Value	**Definition**
High	Best known, only example or above average example and / or significant or high potential to contribute to knowledge and understanding and / or outreach. Assets with a demonstrable international or national dimension to their importance are likely to fall within this category; • wrecked ships and aircraft that are protected under the Protection of Wrecks Act 1973, Ancient Monuments and Archaeological Areas Act 1979 or Protection of Military Remains Act 1986 with an international dimension to their importance, plus as-yet undesignated sites that are demonstrably of equivalent archaeological value; and • known submerged prehistoric sites and landscapes with the confirmed presence of largely in situ artefactual material or palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape.
Medium	Average example and / or moderate potential to contribute to knowledge and understanding and / or outreach; • includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation; and • prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.

Low	Below average example and / or low potential to contribute to knowledge and understanding and / or outreach; • includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation; and • prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	Poor example and / or little or no potential to contribute to knowledge and understanding and / or outreach. Assets with little or no surviving archaeological interest.

3.6 Assumptions and limitations

Archaeological data

3.6.1 Data used to compile this report consists of secondary information derived from a variety of sources, only some of which have been directly examined for the purposes of this study. The assumption is made that the data, as well as that derived from other secondary sources, are accurate.

3.6.2 The documentary sources outlined in paragraph 3.2.3 are not a record of all surviving cultural heritage assets, rather a record of the discovery of a wide range of archaeological and historical components of the marine historic environment. The information held within these datasets is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown. In particular, this relates to buried archaeological features.

3.6.3 There were no records located within the study area held by Cadw, NMRW and GGAT HER.

4 MARINE ARCHAEOLOGICAL ASSESSMENT: PALAEOGEOGRAPHY

4.1 Geological baseline and archaeological potential

4.1.1 The following is an overview of the Quaternary geological and archaeological history of the wider region from the Pleistocene to the Holocene marine transgression. This is based on a range of secondary sources, including academic papers, monographs, geological information (e.g. BGS mapping), and previous work undertaken by Wessex Archaeology within the Severn Estuary and the wider region (Bicket and Tizzard 2015).

4.1.2 The study area is located within the Upper Severn Estuary (Figure 1). Bedwyn Sands is an intertidal sand flat composed of sediments which range from sand to pebble-sized material, whilst NMG Areas are located between the wider intertidal sandbanks and flats of the Middle and Welsh Grounds, consisting of sand wave and ripple features. (ABPmer 2022a).

4.1.3 The basal geology of the Severn Estuary area is Cretaceous or older in origin, with sloping bedrock platforms consisting of Triassic mudstones, Lias limestones and Carboniferous limestones (Brown 2005). However, the modern Severn Estuary is thought to have its origins in the Tertiary period, as large, regional uplift after the end of the Cretaceous resulted in the estuary and surrounding areas being exposed as a subaerial environment (Tappin et al. 1994). The result of this was general erosion of the underlying geology, but with deposition of terrestrial sediment in some areas following the development of a fluvial system along the present estuary (ibid.,36).

4.1.4 Due to this mainly erosional regime, limited remnant Tertiary sediments are present within the area, with any significant areas of deposition generally centred on fault zones (Tappin et al. 1994). This situation continued into the Quaternary, and very little evidence remains from this period until the mid to late Pleistocene (ibid.,76).

4.1.5 As with the rest of the UK, the Pleistocene history of the area is dominated by successive glacial advance/retreat cycles and the associated changes in sea level and sediment regimes. Only the Anglian glaciation (c. 480,000 - 423,000 BP) is thought to have actually covered the area, although the later Devensian glacial maximum (c. 18,000 BP) is thought to have reached as far as the northern edge of the Bristol Channel (Ehlers et al. 2011).

4.1.6 Despite this, the changes in sediment regime created by the successive glacial advances and retreats will have greatly affected the area, and, as such, it is thought that most Pleistocene sediments once present within the area will have been reworked and/or removed due to these changing environmental conditions (Tappin et al. 1994).

4.1.7 Deposits expected to have survived in the area are those dating from between the Devensian glacial maximum and the present day. At the glacial maximum, sea levels are interpreted to have been approximately 120 m lower than the present day. Work undertaken by the University of Birmingham as part of the West Coast Palaeolandscapes project (Fitch and Gaffney 2011) suggests that the Bristol Channel at this time was a broad, relatively flat plain containing numerous rivers, lakes and floodplains.

4.1.8 The Severn Estuary has been a focus for human settlement and subsistence for millennia. For long periods since the first recorded hominid activity in Britain around 970,000 BP (Parfitt et al. 2005; Parfitt et al. 2010), much of the Severn Estuary would have been exposed at times of lower sea level and has been modified by fluvial processes and repeated marine transgressions and regressions during the Pleistocene. The most recent marine transgression developed around 12,000 years ago (Sturt et al. 2013), and this resulted in the formation of the Bristol Channel.

4.1.9 At times when more temperate conditions coincided with these low sea levels, areas that are now submerged would have been suitable for human occupation (Sturt et al. 2016). Consequently, these palaeolandscapes would have been available for prehistoric hominins to traverse and exploit leaving similar prehistoric material as is found in present-day terrestrial settings. Finds recovered from the foreshore in the Severn Estuary have included Palaeolithic hand axes, Mesolithic footprints and stone tool scatters (Severn Estuary Partnership, accessed June 2023).

4.1.10 There are no recorded prehistoric sites within the study area, however the potential for prehistoric material and find spots to exist should not be discounted. Although often associated with fluvial environments, these sites may have been many miles from the sea at the time they were being exploited by our ancestors (Oxley and O'Regan 2001).

4.1.11 The Severn Estuary has one of the richest and most varied archaeological landscapes in Europe (Sturt et al. 2016). It is possible that further remains relating to such early human activity are present in the study area, particularly if organic-rich deposits are encountered. Surviving evidence of prehistoric activity on the seabed can manifest as landscape features (commonly linked to subsistence strategies), palaeoenvironmental remains, or physical artefacts such as worked flints.

4.1.12 It is assumed that most prehistoric archaeological finds from the Bristol Channel will be of Palaeolithic or earlier Mesolithic date (see Bell 2000; Bell et al. 2000). Evidence of human occupation preserved in Mesolithic sediments have been revealed through the inter-tidal erosion of deposits on both sides of the estuary at Brue Valley on the Somerset Levels (Rippon, 1997) and the Gwent Levels Historic Landscape Area on the Welsh coast. Alluvial deposits following the last glaciation 8,000 years ago, now known as the Gwent Levels, can preserve artefactual and palaeoenvironmental evidence of local human occupation from the Mesolithic period.

4.1.13 The recovery of material from later periods (i.e. since 8,000 BP) will generally be confined to intertidal and nearshore locations due to their post-dating the principal episode(s) of Holocene marine transgression (Sturt et al. 2013). In practical terms, post-depositional factors can dictate that very little material will be in primary context and it will retain the similarly limited spatial and temporal integrity as terrestrial assemblages, thus restricting the level of interpretation that can be attempted.

4.1.14 Although out of context, any recovered prehistoric material would almost certainly have the potential to provide insights into patterns of past human land use and demography (Hosfield et al. 2009).

4.1.15 The gradual rise in sea level following the Devensian glacial maximum resulted in a retreat of the shoreline to its approximate present-day position by around 8,000 BP (Tappin et al. 1994). The sediments associated with the post-Devensian landscape may be preserved in places within the Severn Estuary, although, especially considering the high tidal range and current strengths within the channel, they may have been eroded and/or reworked into the modern seabed sediment.

4.1.16 From grab sample evidence the BGS has identified a number of modern sediment units present in the region. In some areas an erosion surface across glaciomarine deposits has been identified. Overlying these are often shallow-water deposits (SL2 member of the Surface Sands Formation), along with the present seabed sediments (SL1 member of the Surface Sands Formation). In the Severn Estuary, the SL1 member deposits can be seen as highly mobile sand waves (Tappin et al. 1994).

4.1.17 Currently the Severn Estuary is a fully marine/estuarine environment, with any new sediment being either of fully marine origin or derived from fluvial sources which drain into the channel.

4.1.18 Post the Holocene marine transgression, the archaeological potential of the study area shifts to the maritime history of the UK, which is presented in Section 5.

Value

4.1.19 The value of different types of prehistoric heritage receptors are shown in Table 2. This is based on the criteria presented in section 3.5.

Table 2 Value of seabed prehistory heritage receptors

Receptor Type	Description	Value
In-situ Prehistoric sites	Primary context features and associated artefacts and their physical setting (if found).	High
	Known submerged prehistoric sites and landscape features with the demonstrable potential to include artefactual material.	
Submerged landscape features (without associated archaeological material)	Other known submerged palaeolandscape features and deposits likely to date to periods of prehistoric archaeological interest with the potential to contain in situ material.	Medium
Isolated Prehistoric finds	Isolated discoveries of prehistoric archaeological material discovered within secondary contexts.	Medium
Palaeoenvironmental evidence	Isolated examples of palaeoenvironmental material.	Low

	Palaeoenvironmental material associated with specific palaeolandscape features of archaeological material	

5 MARINE ARCHAEOLOGICAL ASSESSMENT: MARITIME AND AVIATION SITES

5.1 Introduction

5.1.1 The following assessment of the maritime and aviation marine archaeological baseline resource is based on records of known shipwrecks, aircraft crash sites and obstructions.

5.2 Designated maritime and aviation sites

5.2.1 There are currently no sites within the study area that are subject to statutory protection from the Protection of Wreck Act 1973, the Protection of Military Remains Act 1986 or the Ancient Monument and Archaeological Areas Act 1979.

5.3 Known maritime and aviation sites

5.3.1 No maritime and aviation records were found within the datasets of the NMRW and GGAT HER. There is one reported maritime site charted by the UKHO located at the upper edge of NMG Area 459 (Figure 2; Appendix 3).

5.3.2 UKHO record 12587 (WA 2001) refers to the distributed remains of a wreck, associated with the wreck of the *Mercia*. The *Mercia* was a British steel-built tug steamer en route from Newport to Bristol with a barge in tow. The vessel foundered in January 1942, 2.5 miles northwest of Avonmouth after being mined. The remains of a wreck were observed in 1945. However, no remains were observed during a helicopter search in 1967.

Value

5.3.3 The present assessment of the value of known and potential archaeology within the study areas is based on data from the UKHO, RCAHMW and HER. This assessment is based on the criteria for assessing archaeological value, as set out in Table 1, and based on available guidance (Cadw 2020; Wessex Archaeology 2011a, b, c).

5.3.4 Each wreck should be assessed on a case-by-case basis, in order to take into account the full range of criteria for assessing value (such as period, rarity, documentation, group value, survival/ condition, potential, build, use, loss, and investigation), however, it is also possible to provide a broad assessment of the sites, based on date categories defined by the Marine Class Description and principles of selection (Wessex Archaeology, 2008).

5.3.5 The *Mercia* was a steel-built tug, propelled by a screw-driven three-cylinder compound engine, with one boiler. While the character and extent of archaeological remains associated with the loss of this vessel is presently unknown, the vessel belongs to a period when there were great changes being made to the way in which vessels were built and used. Although examples of vessels from this period are generally more numerous in the archaeological record, those that contribute to an understanding of these changes would be considered as having increased value.

5.3.6 The vessel represents an important role within the Severn Estuary during Second World War. However, as the remains of the wreck are recorded as dispersed and has not since been observed, it is considered to have medium value until further material comes to light.

5.3.7 There are currently no known aircraft crash sites within the study area. Nonetheless, there is the potential for aircraft or aircraft-related debris to exist on the seafloor within the study area. Given the identified potential for the area for military aircraft crashes, particularly relating to the Second World War, the likelihood would be for any aircraft crash to be of military origin, which would be protected under the Protection of Military Remains Act 1986 and therefore would be of high value. This would include both Allied and Axis aircraft and would relate to both complete aircraft wrecks and debris scatters.

5.4 Maritime archaeological potential

Introduction and general historical background

5.4.1 Many vessels were lost without a record being made, and sometimes even the records that were created have since been lost (Cant 2013). Examining the recorded losses discussed above provides an indication to the potential for further discoveries, as do the factors discussed below.

5.4.2 The exploitation of the marine environment is thought to have begun in the Mesolithic, at the earliest time of inundation of the coast, when people would have started to use boats to access the available resources and maintain links with other communities.

5.4.3 Maritime traffic was being undertaken during the Neolithic, with the importation of domesticated animals and other goods from the Continent. The remains of an ancient submerged forest dating from the mid Mesolithic to the Bronze Age along the western coast of the estuary (Timpany 2005) is a reminder of a landscape that was once utilised by human and animals that has the potential to yield archaeological remains.

5.4.4 There has been relatively little direct study of aspects of maritime and coastal activity from the later prehistoric periods in Wales. Studies of long-distance trade and exchange of cultures traditionally focus on stone and flint tools and their geological provenance, rather than maritime networks. Evidence for seafaring is usually inferred from the identification of Mesolithic sites on islands, which must have required some form of craft to complete the sea crossing. Skinboats may have been used, but logboats are certainly known from mainland Europe during this period.

5.4.5 Continuing into the Bronze and Iron Ages, there is a long period which is marked only by a few significant maritime/coastal artefact and boat finds, whilst dramatic changes in society, technology and economy are well attested in terrestrial monuments and material culture. Evidence for roundhouses and pottery from this period have been exposed on the foreshore at Rumney, Cardiff and Magor in Manmouthshire. There is also evidence of a prehistoric plank boat fragment dating to the Bronze Age, which was discovered at Caldicot Castle, Gwent (Parry and McGrail 1991).

5.4.6 The Roman occupation of Britain was by necessity accomplished by ‘maritime’ means, with the classis Britannica operating both for exploration and like a state haulage company in the first centuries of occupation. Apart from the Barland’s Farm boat, no other vessels from the Roman period have been discovered in Wales. The Barland boat was built of oak in the Romano-Celtic tradition, with planks caulked with twisted withies of hazel or willow to prevent leaks. Plant remains found between the ship’s planks were identified as cereal grains, showing that the boat may have been used to transport agricultural produce. It is estimated that the boat could have carried over 6 tonnes of cargo (Nayling and McGrail 2004). During the Roman rule, the Twentieth Legion was established in Gloucester, with vessels plying the estuary, increasing trade. This is visible by the development of ports along the Avon and Parrett.

5.4.7 Into the early medieval period, there is much more evidence for coastal settlement where maritime communities shared cultural contact around the Bristol Channel, and into the Western Approaches with contact with continental Europe. From the 6th to 7th century onwards, it has been suggested that proto-harbours began to emerge from sheltered beaches along with specialist seafaring traders – often associated with princely strongholds such as Dinas Powys, Hen Gastell, Deganwy and Tenby (Rees et al 2017).

5.4.8 Maritime Wales in the Middle Ages: 1039 - 1542 (Gruffydd 2016) highlights that the maritime medieval archaeological record is sparse – including only the 12th century logboat of Llyn Padarn, the 13th century clinker-built vessel carrying iron ore from Magor Pill, and the 15th century 'Newport Ship'. During this period, settlements such as Newport sought and received borough charter status to access to water transportation, which included trade with English possessions overseas.

5.4.9 Post-medieval and modern wrecks, as they were generally made of more substantial material, are more likely to have been discovered through surveys undertaken by the UKHO and others, and thus recorded in the archaeological record. However, there is still potential for discovery of previously unrecorded wreck sites, particularly of wooden wrecks, broken up wrecks or partially buried wrecks that are more difficult to detect through geophysical survey.

5.4.10 The range of seafaring and seascape related research topics expands exponentially from the medieval period into the modern day, with a substantial number of vessels lost as a result of enemy action during the two World Wars.

5.4.11 Although no finds have been reported through the BMAPA Protocol from the study area, one find was reported in 2008 from dredged material from license area 391, approximately 3 km west of Avonmouth. This consisted of a modern lead object (Hanson_0175) and although it was not possible to determine function or provenance of the find, it highlighted the potential for further material to be discovered within the area (BMAPA 2008).

5.4.12 Much of the presently available research is related to the expansion in trade in various Welsh commodities such as copper, coal, slate and other stone trades, and associated port developments. The Welsh ports of Newport and Cardiff were access by ships entering the Bristol Channel. The maritime prominence of the Bristol Channel provided access to, and intensive usage of, the Irish Sea, Western Atlantic, and English Channel as major shipping routes from the late medieval period up to the present day. Many of these ports became major conurbations during the late medieval period and the intervening centuries saw expanding trade and industry with a resultant increase in the commercial use of the Bristol Channel, which continues to facilitate a large volume of maritime traffic (MarineSpace *et al.* 2012: 105).

Navigational hazards

5.4.13 The study area falls within the Severn Estuary, an area of medium potential for navigational hazard. Reference in Sailing Directions for the Bristol Channel (4th edition, Admiralty 1884) makes reference to the Middle Ground sandbank, providing sailing directions and anchorage points.

5.4.14 The study area falls within an area of significant shipping and navigation activity. These include the passage of merchant vessels, recreational craft, military vessels, and vessels engaged on specialist operations such as aggregate dredgers.

Recorded losses

5.4.15 As discussed in section 3.2, Recorded Losses are records for ships or aircraft that are known to have wrecked or crashed offshore, but for which the exact locations are not known. Recorded Losses are often grouped together by their general area of loss into Maritime Named Locations (displayed spatially as polygons or centre points of polygons, often associated with NMRW and NMHR data, for example Welsh Grounds Avon Maritime Named Location), however many records are given co-ordinates (displayed spatially as points), although these are similarly unsubstantiated.

5.4.16 Recorded Losses can be considered as an indication of the potential for archaeological maritime remains to exist within the study area and the type and number of wrecks that could be present. These records relate to vessels reportedly lost or for which no physical wreck remains have ever been identified.

5.4.17 Within the wider area of the study area, 28 records held by NMHR dataset are noted, including the iron hulled sloop *Charlotte* (NMHR_1382763) and iron hulled steamship *Nathan* (NMHR_1382800). These are records for which although a vessel (or vessels) is known to have been lost in the general area, no material has been encountered on the seabed at the recorded location. A full list of records are listed in Appendix 4.

Overview

5.4.18 The evidence for coastal and maritime activity within the vicinity of the study area is considered with reference to the composite time line for shipwrecks around the UK, produced by Wessex Archaeology (2008b) (see Table 3). The timeline takes into account the broad chronology of shipbuilding and employment and draws out a few generalisations regarding the age and special interest of vessels.

Table 3 Summary of key areas of maritime potential

Period	Summary
Pre - 1500	Potential for material associated with prehistoric maritime activities, including coastal travel, fishing and the exploitation of other marine and coastal resources. Vessels of this period include rafts, hide covered watercraft and log boats. The discovery of small finds in the intertidal zone highlights the potential for early maritime activity.
	Potential for material associated with later prehistoric maritime activities, including seaworthy watercraft suitable for overseas voyages to facilitate trade and the exploitation of deep-water resources. Such remains are likely to comprise larger boat types, including those representing new technologies such as the Bronze Age sewn plank boats, including the boat fragment found at Caldicot Castle, Gwent. Evidence for roundhouses have previously been excavated in South Wales and therefore, maritime activity could have been taking place during this period.
	The study area is very close to the major settlement and trading port of Newport, which remains an important centre for manufacturing and engineering. In addition, there is considerable potential for material of Romano-British date, associated with the expansion and diversification of trade with the Continent. Watercraft of this period, where present, may be representative of a distinct shipbuilding tradition known as 'Romano-Celtic' shipbuilding. This is exemplified by the discovery of Barland's Farm boat which had the potential to carry over 6 tonnes of cargo.
	In addition, there is potential for material associated with coastal and seafaring activity in the 'Dark Ages', associated with the renewed expansion of trade routes and Germanic and Norse invasion and migration. Vessels of this period may be representative of new shipbuilding traditions including changes in technique.
	Potential for material associated with medieval maritime activity, including that associated with increasing trade between the UK and Europe, the development of established ports around the southern North Sea and the expansion of fishing fleets and the herring industry. Vessels of this period are representative of a shipbuilding industry which encompassed a wide range of vessel types (comprising both larger ships and vernacular boats). Such wrecks may also be representative of new technologies (e.g. the use of flush-laid strakes in construction), developments in propulsion, the development of reliable navigation techniques and the use of

	ordnance. The Newport Ship is one of the most well preserved and intact examples of a fifteenth century ship; its excavation has revealed a lot about ship construction, cargo capacity, life on board and trade networks of the 15th century.
1501 to 1815	Vessels of this period continued to variously represent both the clinker techniques and construction utilising the flush-laid strakes technique. There is increasing potential for post-medieval shipwrecks associated with the expansion of transoceanic communications and the opening up of the New World. There is increasing potential for post-medieval shipwrecks associated with continuing local trade and marine exploitation.
1816 to 1913	Increasing potential for the discovery of shipwrecks associated with the introduction of iron and later steel in shipbuilding techniques. Such vessels may also be representative of other fundamental changes associated with the industrial revolution, particularly with regards to propulsion and the emergence of steam propulsion and the increasing use of paddle and screw propelled vessels. Potential for the discovery of shipwrecks demonstrating a diverse array of vernacular boat types evolved for use in specific environments. Potential for wrecks associated with large scale worldwide trade, the fishing industry or coastal maritime activity including marine exploitation.
1914 to 1945	Potential for the discovery of shipwrecks associated with the First and Second World Wars, including both naval vessels and merchant ships. Wrecks of this period may also be associated with the increased shipping responding to the demand to fulfil military requirements. A large number of vessels dating to this period were lost as a result of enemy action.
Post - 1946	Potential for wrecks associated with a wide range of maritime activities, including military, commerce, fishing and leisure. Although ships and boats of this period are more numerous, losses declined due to increased safety coupled with the absence of any major hostilities. Vessels dating this period are predominantly lost as a result of any number of isolated or interrelated factors including human error, adverse weather conditions, collision with other vessels or navigational hazards or mechanical faults.

5.5 Aviation archaeological potential

5.5.1 The two World Wars provide two historical periods when the sea lanes became theatres of war. The relationships between defence of the sea lanes and Welsh airfields provides another potential research area.

5.5.2 During the Second World War, aircraft activity increased drastically and the highest potential for aircraft material on the seafloor is from this period. By the Second World War, aircraft were more heavily built and therefore material from their crash sites is more likely to survive in the archaeological record.

5.5.3 The Aircraft Crash Sites at Sea project (Wessex Archaeology 2008b) considered a selection of sources which may be considered to indicate the potential for aircraft remains of this period. One of the most complete sources of information was provided by published aviation researcher Ross McNeill, who identified 11,090 RAF aircraft losses in the North Atlantic, North Sea, English Channel, Irish Sea and Biscay areas between 1939 and 1990, the majority of which occurred during the Second World War (Wessex Archaeology 2008b: 18).

5.5.4 After the Second World War, there is still potential for aircraft to have been lost in the area, however any military losses during this period are more likely to have been lost due to training accidents rather than combat operations (Wessex Archaeology 2008b: 166), and civilian losses are likely to have been reported and recorded.

Recorded Losses

5.5.5 Within the wider Severn Estuary a number of records of aircraft losses are noted, including a Gladiator MKII N5632, a German Air Force Heinkel He 111, a Spitfire MK IIA P7676 and Blenheim MK I L1471. These are records for which although an aircraft is known to have been lost in the general area, no material has been encountered on the seabed at the recorded location.

Overview

5.5.6 There is potential for the presence of aviation material dating from the early 20th century until more recent times, with a concentration dating to the World Wars and in particular the Second World War. Discoveries may occur anywhere within the study area, but potential may increate nearer the coastline.

5.5.7 The key area of aviation potential that may be uncovered within the study area are summarised in Table 4.

Table 4 Summary of key areas of aviation potential

Period	Summary
Pre-1939	Minimum potential for material associated with the early development of aircraft. Aircraft of this period may represent early construction techniques (e.g. those constructed of canvas covered wooden frames) or may be associated with the mass-production of fixed wing aircraft in large numbers during the First World War.
	Minimum potential for material associated with the development of civil aviation during the 1920s and 1930s, associated with the expansion of civilian flight from the UK to a number of European and worldwide destinations.
1940 to 1945	Very high potential for Second World War aviation remains, particularly as the east coast acted as a hub for hostile activity. Aircraft of this period are likely to be representative of technological innovations propelled by the necessities of war which extended the reliability and range of aircraft. This potential is signified by the aircraft Recorded Losses outlined above.
Post- 1945	Potential for aviation remains associated with military activity dominated by the Cold War, the evolution of commercial travel and recreational flying and the intensification of offshore industry (including helicopter remains). Aircraft of this period may be representative of advances in aerospace engineering and the development of the jet engine.

5.5.8 All aircraft that crashed while in military service are automatically protected under the Protection of Military Remains 1986. If present, such sites would represent constraints upon the proposed development. This legislation means any activities impacting upon the aircraft remains must cease pending assessment by the Ministry of Defence (MoD).

6 ASSESSMENT OF HISTORIC SEASCAPE CHARACTER

England

6.1.1 The assessment of the HSC within the English sub-sector of the study area was undertaken using the results of LUC's 2017 Historic Seascape Characterisation (HSC): Consolidating the National HSC Database, which consolidated the eight existing HSC implementation projects (undertaken between 2008 and 2015) into a single national database.

6.1.2 The method assesses and defines areas with HSC types that promote an understanding of historic trends and processes, to inform the sustainable management of change over time. This is achieved by addressing the multi-level character of the sea, by splitting the marine zone into five tiered levels: the coastal area, the sea surface, the water column, the sea floor, and the subsea floor. The characterisation is GIS based, enabling key characteristics to be identified. The English sub-sector study area has been characterised as having the following elements:

- Industry – extractive industry – marine aggregates dredging
- Navigation – navigational hazard – drying hazard.

Wales

6.1.3 The assessment of the HSC within the Welsh sub-sector of the study area was undertaken using the studies carried out by NRW. Working on behalf of the Welsh Government, NRW carried out a study to identify the character of Wales's seascapes at a broad scale (NRW 2015b). Seascapes, like landscapes, reflect the relationship between people and place; marine character areas highlight the key natural, cultural and perceptual influences that make the character of each seascape distinct and unique. Seascapes are about linking people and their cultures, and places and their natural resources. This is important as it allows us to understand and appreciate sense of place and local distinctiveness. There are 29 marine character areas in Welsh territorial waters and there is spatial information and a description for each of them. This forms part of the information underpinning the Welsh National Marine Plan. Marine character areas and the effects of development on them should be considered when drawing up and assessing project proposals (Cadw 2020).

6.1.4 The study area spans across Marine Character Areas 29: Severn Estuary (Natural Resources Wales 2015a). The below information (Table 5) highlights mud, sand and gravel sediments. Such deposits can provide archaeological potential as there could be buried material in the sediments that cannot be detected by geophysical survey. Other characteristics noteworthy include navigational hazards, exploitation of natural resources by humans for millennia, area of trade and navigation and immense tidal range of the estuary.

Table 5 Marine Character Area 29

Key Characteristics
Expansive funnel-shaped Severn Estuary, sitting at the mouth of four major rivers (the Severn, Wye, Usk and Avon).
The immense tidal range of the estuary is second only to the Bay of Fundy in Canada. The status of the tide has a significant bearing on perceived character.
Soft Triassic and Jurassic rocks exposed along the shore, creating a wide rocky intertidal area. Elsewhere the shore is defined by extensive tidal flats.
Mud, sand and gravel sediments deposited in the Holocene period producing a varied sea bed of flats and bars, with associated shallow waters and numerous shoals presenting hazards to navigation.
Flat Holm island (SSSI and LNR) forms a gateway feature in the west – an outcrop of harder limestone rising out of the surrounding sediments. Steep Holm forms a similar 'twin' feature in English waters to the south.
Estuary important for the interpretation of coastline dynamics and land-forms, and also past changes in sea level, sediment supply, climate and river flow.
Strong tidal streams and turbidity producing biological communities characteristic of the extreme physical conditions of liquid mud and tide-swept sand and rock.
Tidal flats, saltmarshes and the extensive wet grasslands are of international importance for wintering waterfowl and migratory birds.
Some of the richest and most diverse populations of non-exploited fish in the UK sea lamprey and twaite shad populations considered to be larger than in any other estuary.
MCA's rich natural resources exploited by humans for millennia, with evidence dating back to the earliest hunter-gatherers roaming what was previously a much larger coastal plain (prior to sea level rise around 6,000 BC).
Long history of coastal reclamation, embankments and diches, notably the extensive Gwent and Wentlooge levels.
Long-standing strategic importance for international trade and maritime navigation, particularly as ports on both sides of the Bristol Channel expanded from the medieval period onwards. Cardiff, Newport and Barry still retain important port functions.
Numerous ship wrecks found on the sea floor, particularly in the west – including examples mined and sunk during WWII.
Local trawlers catch plaice, turbot, whiting and rays from the MCA's sandbanks. Recreational charters and beach-based fishing are important economic activities.

Salmon, eels and trout fished commercially and recreationally in the rivers feeding the estuary, including through the traditional method of putcher fishing (medieval intertidal fishtraps are located at Goldcliff, West Pill and Caldicott).
Flat coastline backed by the Wales Coastal Path, affording long views into the Bristol Channel. Cars travelling along the M4 via the Severn Bridge also overlook the area.
Views to major commercial, port and industrial development at Cardiff and Avonmouth, as well as the two road bridges, contrasting with the open, empty vistas characterising the Gwent Levels.
Seascape's open character affording strong intervisibility with the Somerset coastline, including Portishead, Clevedon and Weston-super-Mare. The higher hill summits of the Quantock Hills AONB and Exmoor National Park form a distinctive upland backdrop.
Estuary's classic funnel shape and south-west orientation make it susceptible to extreme weather conditions (including storm surges) sweeping in from the east Atlantic.

7 POTENTIAL IMPACTS AND RECOMMENDATIONS

7.1 Potential Impacts

7.1.1 Archaeological assets relating to seabed prehistory, maritime and aviation archaeology have been identified within the study area, as has the potential for further assets to be discovered. The proposed aggregate dredging has, in principle, the potential to physically impact potential archaeological receptors within the dredging footprint; and known and potential receptors in the wider area as a result of indirect physical effects such as changes in seabed sediment regimes, scour etc.

7.1.2 Typically, adequate and appropriate mitigation is required to ensure that the archaeological value of the baseline environment described within this report is maintained. Recommendations for appropriate mitigation are set out below.

7.2 Recommendations

Avoidance

7.2.1 The primary mitigation for the protection of known archaeological assets is avoidance. This is achieved through the implementation and monitoring of Archaeological Exclusion Zones (AEZs), which are proposed for identified high value seabed features.

7.2.2 The mitigation will establish appropriately sized AEZs around assets which have been considered to be of high archaeological potential, in consultation with the Archaeological Curator. These areas would be out of bounds to construction activities and to anchoring. Monitoring of any AEZs to ensure there is no disturbance to them will be part of this mitigation.

7.2.3 One historic record (WA 2001) of possible archaeological interest with no corresponding geophysical anomaly has been identified. As a record of potential archaeological interest, a precautionary AEZ of 100 m is recommended on the UKHO position of the site (Figure 3). This will ensure that the site is avoided if there is the potential for it to be impacted by any development. Further work may be necessary to ascertain the archaeological potential of this feature should avoidance prove unfeasible.

7.2.4 It is recommended that if any objects of possible archaeological interest are recovered during any dredging operations, they should be reported using the established Marine Aggregate Industry Protocol for the Reporting of Finds of Archaeological Interest (BMAPA, English Heritage and The Crown Estate 2005).

Reduction

7.2.5 Reduction of impact can be achieved by means of appropriate mitigation identified through potential opportunities for further investigation of assets (e.g., during UXO survey and clearance, or a sampling strategy such as grab sampling). Further investigations mean that anomalies can either have their archaeological value removed, if they prove to be of non-anthropogenic nature or modern, or their value as archaeological assets confirmed. If their value is confirmed, mitigation in the form of either avoidance (which may be enacted by the implementation of an AEZ) or through remedying or offsetting measures (through targeted removal through archaeological excavation or lifting) and reporting of the find through mechanisms such as a Protocol for Archaeological Discoveries.

Remedying and offsetting

7.2.6 In cases where avoidance is either inappropriate or impossible, the damage to archaeological assets should be offset. This could include re-stabilising sites after they have been disturbed of archaeologically recording sites that cannot be preserved. In the case of seabed prehistoric features, this could be achieved by undertaking a palaeoenvironmental assessment of deposits with high geoarchaeological potential, principally peat deposits. Pollen and macrofossil assessment, supported by radiocarbon dating, will provide information on age and vegetation history of the terrestrial environment, providing a landscape context to any prehistoric activity within the area.

7.2.7 Recovery of artefacts and/or other archaeological assets should be a final resort, when all other mitigation has failed. Any recovery should be completed under the supervision of an appropriately qualified and experienced marine archaeologist. Safe archaeological recovery can take many forms, from grabs of individual artefacts to Remotely Operated Vehicle (ROV) collection, to full diver assisted lifts. Due to the vast differences in practice and implementation between these methods, each will be covered by a specific Method Statement, approved by the Archaeological Curator, should they be implemented.

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Coflein

Available here: https://coflein.gov.uk/en/site/544099/ (Accessed June 2023)

APPENDICES

Appendix 1: Terminology

Abbreviations/Acronyms

AD	Anno Domini
ALSF	Aggregate Levy Sustainability Fund
BCE	Before Common Era
BGS	British Geological Survey
BH	Borehole
BNG	British National Grid
BP	Before Present
BULSI	Build, Use, Loss, Survival and Investigation
CIfA	Chartered Institute for Archaeologists
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DCLG	Department for Communities and Local Government
ECC	Export Cable Corridor
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ES	Environmental Statement
GIS	Geographic Information System
HER	Historic Environment Record
HSC	Historic Seascape Characterisation
JNAPC	Joint Nautical Archaeology Policy Committee
LGM	Last Glacial Maximum
MCA	Marine Character Area
MCAA	Marine and Coastal Access Act 2009
MHWS	Mean High Water Springs
MoD	Ministry of Defence
MPS	Marine Policy Statement
N/A	Not applicable (not included in dataset)
NM	Nautical Miles
NMHR	National Marine Heritage Record
NRHE	National Record of the Historic Environment
NRW	Natural Resources Wales
PEIR	Preliminary Environmental Information Report
PPW	Planning Policy Wales
RCAHMW	Royal Commission on the Ancient and Historical Monuments of Wales
ROV	Remotely Operated Vehicle
UKHO	United Kingdom Hydrographic Office
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UTM	Universal Transverse Mercator
WA	Wessex Archaeology

Chronology

Where referred to in the text, the main archaeological periods are broadly defined by the following date ranges:

Prehistoric	
Palaeolithic Lower Palaeolithic Pre-Anglian to Ipswichian Middle Palaeolithic Devensian to LGM Upper Palaeolithic Post-LGM and early Holocene Late Upper Palaeolithic	970,000 – 9500 BCE 970,000 – 300,000 BCE >478 ka – 115 ka; >Marine Isotope Stage (MIS) 12 – 5e 300,000 – 40,000 BCE c. 115 ka – 18 ka; MIS 5d -2 40,000 – 10,000 BCE 18,000 – 6,000 BP; MIS 2-1 12,000 – 9500 BCE
Early Post-glacial	9500 – 8500 BCE
Mesolithic	8500 – 4000 BCE
Neolithic	4000 – 2400 BCE
Bronze Age	2400 – 700 BCE
Iron Age	700 BCE – AD 43

Historic	
Romano-British	AD 43 – 410
Saxon	AD 410 – 1066
Medieval	AD 1066 – 1500
Post-medieval	AD 1500 – 1800
19th Century	AD 1800 – 1899
Modern	1900 – present day

Appendix 2: Legislation, Policy and Guidance

Designation	*Associated Legislation or Policy*	Overview
Protected Wreck Sites	*Protection of Wrecks Act* 1973	The *Protection of Wrecks Act* 1973 allows the Secretary of State to designate a restricted area around a wreck to prevent uncontrolled interference. These statutorily protected areas are likely to contain the remains of a vessel, or its contents, which are of historical, artistic or archaeological importance.
	Marine and Coastal Access Act 2009	Marine licensing and marine planning made the responsibility of the National Resource Wales (NRW) and Marine Management Organisation (MMO). The Welsh National Marine Plan (2019) is the first marine plan for Wales and is intended to guide the sustainable development of the marine area by setting out how proposals will be considered by decision makers. England's inshore and offshore waters have been divided into 11 plan areas, for which marine plans are being produced by the MMO.
Protected Places and Controlled Sites	*Protection of Military Remains Act 1986*	The *Protection of Military Remains Act* 1986 provides protection for designated military vessels and for all aircraft that crashed while in military service. The Act provides two types of protection: Protected Places (wrecks designated by name and can be designated even if the location of the site is not known) and Controlled Sites (sites designated by location – covers wrecks within the last 200 years). It is illegal to disturb sites or remove anything from sites. Protected Places can be visited by divers, but the rule is look but don't touch. For Controlled Sites it is illegal to conduct any operations (including diving or excavation) within the Controlled Site unless licensed to do so by the Ministry of Defence.
	Merchant Shipping Act 1995	This Act sets out the procedures for determining the ownership of underwater finds that turn out to be 'wreck', defined as any flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ship, aircraft, hovercraft, parts of these, their cargo or equipment. If any such finds are brought ashore, the salvor is required to give notice to the Receiver of Wreck. This Act is administered by the Maritime and Coastguard Agency.
	UNESCO Convention on the Protection of the Underwater Cultural Heritage	The UNESCO Convention was concluded in 2001 and is a comprehensive attempt to codify the law internationally, with regards to underwater cultural heritage. The UK abstained in the vote on the final draft of the Convention, however it has stated that it has adopted the Annex of the Convention, which governs the conduct of archaeological investigations, as best practice for archaeology. Although the UK is not a signatory, the Convention entered into force on 2nd January 2009, having been signed or ratified by 20 member states. It has since been ratified or accepted by an additional 72 member states.

Appendix 3: Known Maritime Sites

WA_ID	External References	Description	Easting	Northing
2001	UKHO_12587 NMHR_1001818	UKHO record of the *Mercia*, described as 'distributed remains of a wreck'. NMHR record of possible remains of a wreck of British steam engine tug which foundered after being mined 2.5 miles NW of Avonmouth on the 14th of January 1942. If the *Mercia*, she was en route from Newport to Bristol with a barge in tow. Constructed in 1889 of steel in Poplar, registered at Bristol from 1935 and belonging to the Fairplay Towage and Shipping Co. Ltd. 221, Avonmouth Road, Avonmouth, Bristol. The vessel was a steam-powered, measuring 85 ft x 18 ft x 10 ft. The remains of a wreck were observed in 1945. However, no remains were observed during a helicopter search in 1967.	343908	181039

Appendix 4: Recorded Losses

NMHR ID	Name	Date of Loss	Description
1382800	*Nathan*	05/03/1901	Foundered and lost in wind conditions W force 7. Place of loss stated as "Off Major, 7.5 miles E of Newport". Built: 1878. Owner: W A Osborn, Bristol. Date of Loss: 1901 wreck of English cargo vessel which foundered 7.5 miles east of Newport while en route from Newport to Bristol with iron. Built in 1878, she was an iron screw steamer.
1387163	*Dolly*	1748-12-08	1748 wreck of an English snow which stranded near Welsh Hook. This sailing vessel was constructed from wood., Crew lost: all `On the 8th Instant, a Snow with bright Sides and a white Bottom, coming up the Bristol Channel in a strong Fret of Wind at South, was force on the Welch Hook, where she stranded and sunk, and `tis feared that all on board perished' ... `The Vessel mentioned in the last List as Lost on the Welch Hook, proves to be the DOLLY, belonging to Dartmouth.'
1612705	Unknown	1835-10-10	Falmouth, Oct. 10. The JOHN, from Newport to Bristol, and a sloop, are lost inside the Welsh Hook...' Actual date of loss, 1835 wreck of a sloop wrecked on the Welsh Hook. See 1612704 for the wreck of the JOHN, lost on the Welsh Hook on the same day.
1442919	Unknown	1675-12-30	The second of at least three colliers known to have been lost from this report: Swanzey, Decemb. 30. The storms continue still very violent...Three or four colliers coming from Bridgwater and Minhead, have been cast away on the Welsh Grounds.' Reporting date of loss, 1675 wreck of collier which stranded on the Welsh Grounds after leaving Minehead. Constructed of wood, she was a sailing vessel.
1002109	*Joannis Scatzoulis*	1877-05-27	Lost in wind conditions SSW force 9. Departed from Samsun, Asia Minor. Passenger was the master's wife. 'BRISTOL - PILL - May 28: The Greek brig JOANNIS SCALTZOUNIS, Giorgio, from Samsoun, last Falmouth for Gloucester, went ashore on the Welsh Hook Sands at 10 o'clock last night and has becme a total wreck. The crew abandoned her full of water, and were taken off by the tug BOB CHAMBERS, and with their effects were landed at Bristol this morning.' Actual date of loss, 1877 wreck of a Greek brig which stranded on the Welsh Hook Sands, while en route from Samsun to Gloucester with a cargo of wheat. She was a wooden sailing vessel.

NMHR ID	Name	Date of Loss	Description
1382691	*May Hodges*	1891-11-11	1891 wreck of Welsh fishing vessel which foundered near the Usk Patch after leaving Newport on a fishing trip; a wooden sailing vessel., Foundered and lost whilst fishing in wind conditions NW force 8. NB: The Usk Patch is closer to the Welsh bank of the Severn Estuary than to the English bank; however, it is not known in which direction off the Usk Patch the loss occurred. This vessel is therefore included in the record to reflect the possibility of loss closer to the English bank. Master: T Hodges Crew: 2 Crew Lost: 2 Owner: T Hodges, Newport
1612703	*Eagle*	1819-10-23	TO BE SOLD BY AUCTION... Part of the stores saved out of the sloop EAGLE, wrecked on the Welsh Hook; consisting of an anchor, running and other rigging, blocks, several sails, three spars, a boat, and various other useful articles...' Reporting date of loss, 1819 wreck of a sloop wrecked on the Welsh Hook.
1612701	Unknown	29/12/1900	... The Penarth lifeboat JOSEPH DENMAN rescued nine men and the master's wife from an Italian barque wrecked on the Welsh Hook...' Reporting date of loss, 1900 wreck of an Italian barque wrecked on the Welsh Hook.
1612700	*Albion*	1874-09-15	1874 wreck of a Welsh cargo vessel strandeded on the Bristol coast, between Welsh Hook and Portishead, while travelling from Newport to an unknown destination with a cargo of coal., '... the ALBION, 46 tons, belonging to Captain Jones, Cae Lleppa, Bangor, from Newport with coals, went ashore off the Bristol coast, between Welsh Hook and Portishead, and is likely to become a total wreck...'
1382786	*Brunswick*	24/12/1900	Stranded in wind conditions S force 1. Wrecked on Hook Sands, 6 nautical miles off Clevedon on 24 December 1900, while en route from Liverpool to Bristol with a general cargo. DISASTER IN BRISTOL CHANNEL. FOUNDERING OF A STEAMER. FEARED LOSS OF SEVEN LIVES.
1435182	*Bacchus*	1728-05-01	Actual date of loss, 1728 wreck of cargo vessel which stranded on the Welsh Hook after grounding on Flat Holm, on her passage from Oporto with wine and other goods. Her departure, cargo, and position of loss are consistent with a destination of Bristol, then heavily involved in the wine trade. Constructed of wood, she was a sailing vessel.

NMHR ID	Name	Date of Loss	Description
1382763	*Charlotte*	1898-11-02	Foundered and lost in wind conditions S force 10. The "Upper Hook Buoy" has not been identified on modern charts but is presumed to be in the vicinity of the Welsh Hook. Date of Loss, 1898 wreck of English sloop which foundered half a mile west of the Upper Hook Buoy en route from Penarth to Bristol with coal. Built in 1848, she was a wooden sailing vessel.
1383083	*Hibernia*	1768-01-26	`The HIBERNIA, Keith, from Philadelphia for Bristol, is lost on the Welch-hook, but the crew are saved.' 1768 wreck of craft which stranded on the Welsh Hook en route from Philadelphia to Bristol; a wooden sailing vessel.
1441776	*Russell*	1696-01-23	1696 wreck of English frigate which stranded on the Welsh Hook after putting into the Bristol Channel "by stress of weather" on her passage from Gallipoli with oil.
1382793	*Tordenskjold*	28/12/1900	1900 wreck of Norwegian barque which stranded on the Welsh Hook after departing Newport for Luanda with coal. Built in 1867, she was a wooden sailing vessel.
1382797	*Tenax Propositi*	28/12/1900	1900 wreck of Norwegian barque which stranded on the Welsh Hook after leaving Newport for Paramaribo with coal. Built in 1878, she was a wooden sailing vessel. She was in company with two other Norwegian barques, lost on the same day in the same place, for which see ST 48 SE 6 and ST 48 SE 7., Stranded and lost in wind conditions SW force 10.
1383089	*Hawke*	1761-11-10	1761 wreck of British craft which stranded on the Welsh Hook en route from Guadeloupe to Bristol; a wooden sailing vessel., `The HAWKE, Thompson, from Guadeloupe for Bristol, is lost on the Welch-hook, but the crew are saved.'
1612707	*Madonna*	1875-02-19	Wreck event and documentary evidence: '...The schooner MADONNA, of and from Waterford (Curran), for Bristol, oats, struck on the Hook Sand off Clevedon on Friday night, bilged and filled. Crew saved and landed at Cardiff in their own boat. Vessel and cargo total loss...' (1) '...Cardiff 20th Feb... The MADONNA, of Dungarvon, for Bristol, with oats, was wrecked on Welsh Hook last evening; vessel and cargo total loss...' (2) Master: Curran (1) Date of loss qualifier: Actual date of loss, 1875 wreck of an Irish schooner which stranded on the Welsh Hook off Clevedon, while en route from Waterford to Bristol with a cargo of oats.

NMHR ID	Name	Date of Loss	Description
1442921	Unknown	1675-12-30	The third of at least three colliers known to have been lost from this report 'Swanzey, Decemb. 30. The storms continue still very violent...Three or four colliers coming from Bridgwater and Minhead, have been cast away on the Welsh Grounds.' Reporting date of loss, 1675 wreck of collier which stranded on the Welsh Grounds after departing from either Bridgwater or Minehead. Constructed of wood, she was a sailing vessel.
1382896	*Mary Ann*	20/06/1911	1911 wreck of English smack which stranded 1 mile west of the Upper Hook buoy en route from Newport to Bristol with superphosphate. Built in 1826, she was a wooden sailing vessel., Stranded/total wreck or loss.
1442904	Unknown	1675-12-30	1675 wreck of collier which stranded on the Welsh Grounds after leaving Bridgwater. Constructed of wood, she was a sailing vessel., The first of at least three colliers known to have been lost from this report: 'Swanzey, Decemb. 30. The storms continue still very violent...Three or four colliers coming from Bridgwater and Minhead, have been cast away on the Welsh Grounds.'
1612702	*Helena*	1810-12-01	FOR SALE BY AUCTION. (For the account of the concerned, and to pay salvage expenses) at the exchange coffee room, on Tuesday next, Dec. 4. at eleven o'clock in the forenoon, All the materials, stores &c saved from the wreck of the American ship HELENA, James Kennedy, master, stranded on the Welsh Hook; consisting of masts, yards, spars, cables, boats, standing and running rigging, sails, anchors &c... At the same time will be sold the hull of the said ship HELENA, as she now lies on the said sand, with all her remaining materials; being almost a new vessel. Her stores and materials are well worth the attention of ship owners, builders, and others...' Reporting date of loss: 1810 wreck of an American vessel, stranded on the Welsh Hook.
1383100	*Hopewell*	1772-10-20	1772 wreck of British passenger vessel which stranded on the Welsh Hook en route from Waterford to Bristol with passengers; a wooden sailing vessel., `The HOPEWELL, Lethybee, from Waterford to Bristol, is lost on the Welsh Hook, and five passengers drowned.'

NMHR ID	Name	Date of Loss	Description
1382787	*Hovding*	28/12/1900	Stranded and lost with all hands in wind conditions SW force 10. Apparently one of a group of Norwegian vessels sailing from Newport to destinations in Portuguese colonies, three of which were wrecked in the same place at the same time, for which see also ST 48 SE 7 and ST 48 SE 8. 1900 wreck of Norwegian barque which stranded on the Welsh Hook en route from Newport to Maceio with coal. Built in 1876, she was a wooden sailing vessel. See also ST 48 SE 7 and ST 48 SE 8 for the other Norwegian vessels lost in company with this vessel in the same incident.
1612706	*Batanga*	1859-11-01	The BATANGA was a small barque, being of 141 tons register, and about 200 tons burden. She was commanded by Capt. Dibden, and had a crew, besides, of seven persons, and she was laden with miscellaneous merchandise which is usually comprised in an African venture...' . Actual date of loss, 1859 wreck of an English barque which stranded on the Welsh Hook, while en route from Bristol to Africa.
1382624	*Confidence*	1885-12-31	Foundered offshore under tow with no crew on board, in wind conditions WSW force 5. 1885 wreck of English craft which foundered off the Usk Patch while under tow from Newport for Bristol; a wooden screw steamer.
1612704	*John*	1835-10-10	Falmouth, Oct. 10. The JOHN, from Newport to Bristol and a sloop, are lost inside the Welsh Hook...'. Actual date of loss, 1835 wreck of a British craft wrecked on the Welsh Hook. See 1612705 for the wreck of a sloop lost on the Welsh Hook on the same day.
1446211	*Mercia*	14/01/1942	1942 wreck of English tug which foundered 2.5 miles NW of Avonmouth, off Portishead, after being mined en route from Newport to Bristol with a barge in tow. Constructed of steel, she was a steam-powered vessel. Iron-built 1889, registered at Bristol from 1935, and belonging to the Fairplay Towage and Shipping Co. Ltd., 221, Avonmouth Road, Avonmouth, Bristol.

Appendix 5: OASIS record form

OASIS ID	wessexar1-*XXX TBC*

Activity Type	
Project identifier	*265480*
Activity type	*Desk Based Assessment*
Reason for investigation	*Planning requirement*
Development type	*Land management > Dredging*
Planning reference	EIA/2022/00044

Location	
Site name	*Bedwyn Sands and North Middle Grounds*
Site code	*265480*
Land use	*Marine*

Reviewers / Admin Area	
Historic Environment Record(s)	*Historic England National Marine Heritage Record*
Archive type	*Digital Archive*
Museum/archive	
National organisation	*Historic England*
HER identifiers	
National organisation identifiers	*NMHR_1001818*

Work Undertaken		
Title	*Bedwyn Sands and North Middle Ground: Marine Archaeology Desk-based Assessment*	
Description / Methodology	*Wessex Archaeology was commissioned by ABPmer to prepare an archaeological desk-based assessment that will in turn inform an Environmental Statement chapter for marine aggregates Bedwyn Sands and North Middle Ground Areas 455 and 459. The areas are located within the Upper Severn Estuary within Welsh and English territorial waters.* *Documentary evidence has been assessed to verify the location and condition of the known and potential archaeological resource within Licence Areas Bedwyn Sands and North Middle Ground, 455 and 459, with regards to seabed prehistory and maritime and aviation archaeology. A discussion on the historic seascape character has also been undertaken for the area.*	
Previous / Future work	*Yes*	*Yes*
Start Date / End date	*4 July 2022*	*July 2023*
Scientific dating	*No*	
Environmental sampling	*No*	
Associated identifiers	*UKHO_12587*	

Report Details	
Title	*Bedwin Sands and North Middle Grounds: Marine Archaeology Desk-based Assessment*

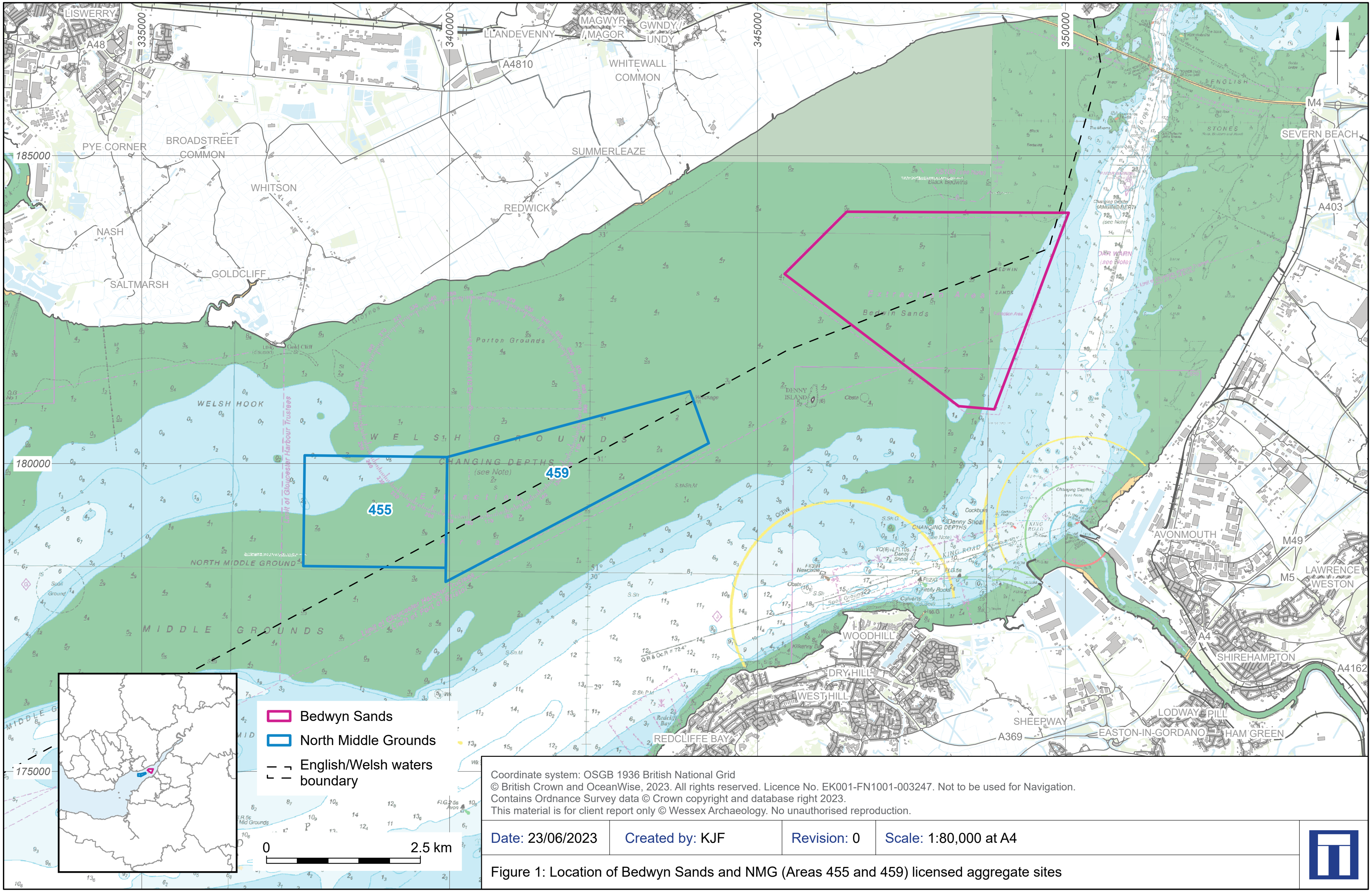
Author	*Stephanie Said*
Publication date	*2023*
Publisher or Producer	Wessex Archaeology
Place of publication or production	*Salisbury*
Other bibliographic Information – report number	265480
Report release delay	*N/A*
Choose File	*Upload report*

People	
Organisation	Wessex Archaeology
Project Manager	*Andrea Hamel*
Expert/Project Officer	*Stephanie Said*
Funder	*ABP Marine Environment Research Ltd.* *Severn Sands Holdings Ltd.*

Keywords	
Significant monuments or artefacts	*No*
Keyword	*Wreck*
Period	*Post-modern*

Results	
Description - outcomes	*The assessment has established that there are the following marine archaeological assets: the potential for organic deposits containing material of palaeoenvironmental interest within the study area; one recorded wreck site within the study area; no known aircraft crash sites; potential for additional currently unknown maritime and aviation seabed features to exist; and the Historic Seascape Character of the area comprising: navigational activity and hazards; shipping activity; extractive industry (minerals); and cultural topography (marine).*
Research framework sections	*N/A*

Archives		
Physical archive / Documentary archive / Digital Archive	*Digital archive* *ts*	
	Title	*Bedwin Sands and North Middle Grounds: Marine Archaeology Desk-based Assessment*
	Location before deposition	*Wessex Archaeology, Salisbury*
	Expected deposition date	*N/A*
	Accession ID	*N/A*
Additional Information		
Related OASIS projects	*Add OASIS IDs of linked projects*	



Coordinate system: OSGB 1936 British National Grid

Date: 23/06/2023	Created by: KJF	Revision: 0	Scale: 1:80,000 at A4

Figure 1: Location of Bedwyn Sands and NMG (Areas 455 and 459) licensed aggregate sites

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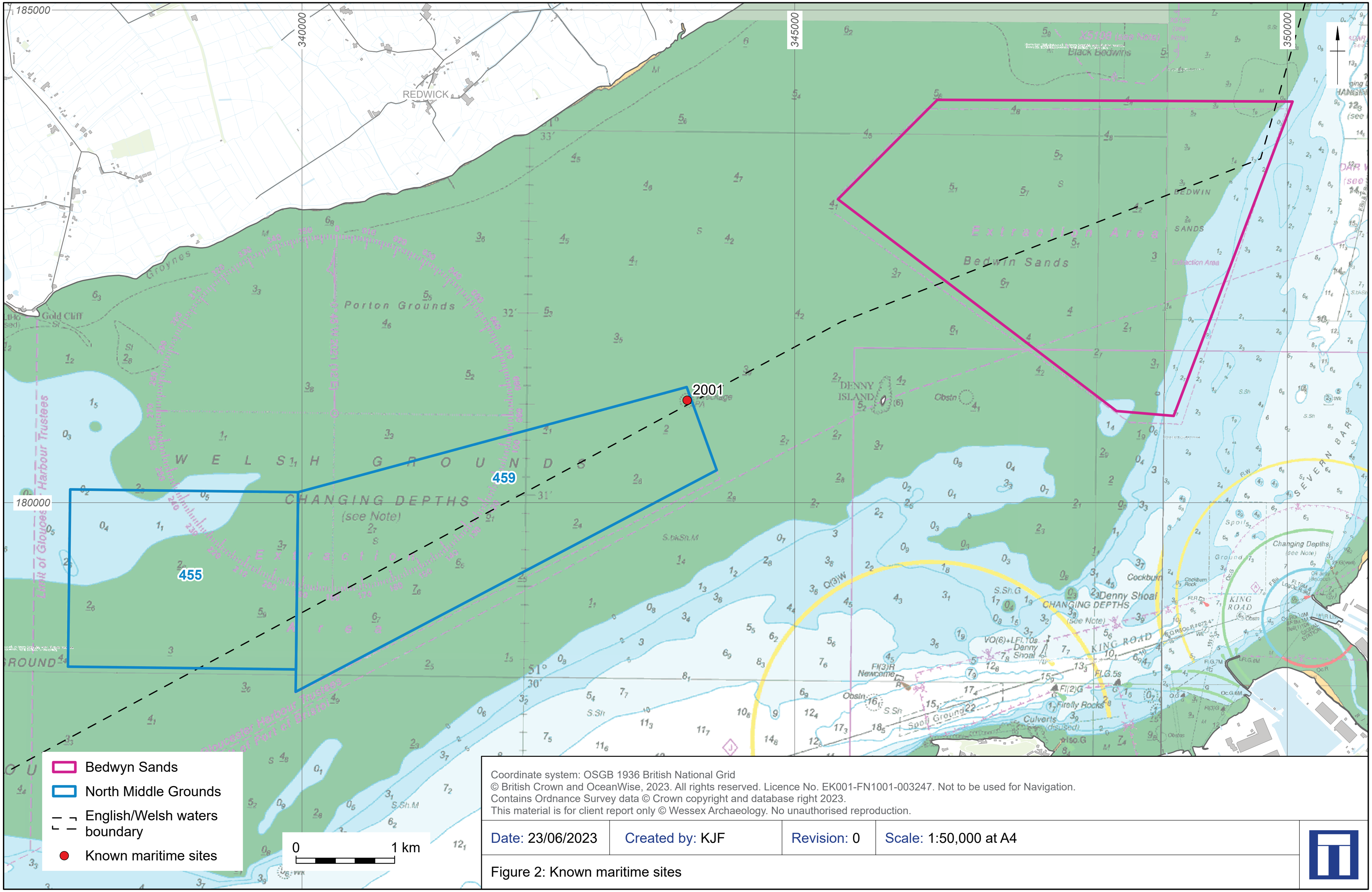

Bedwyn Sands
North Middle Grounds
English/Welsh waters boundary
Known maritime sites

0 1 km

Date: 23/06/2023 | Created by: KJF | Revision: 0 | Scale: 1:50,000 at A4

Figure 2: Known maritime sites

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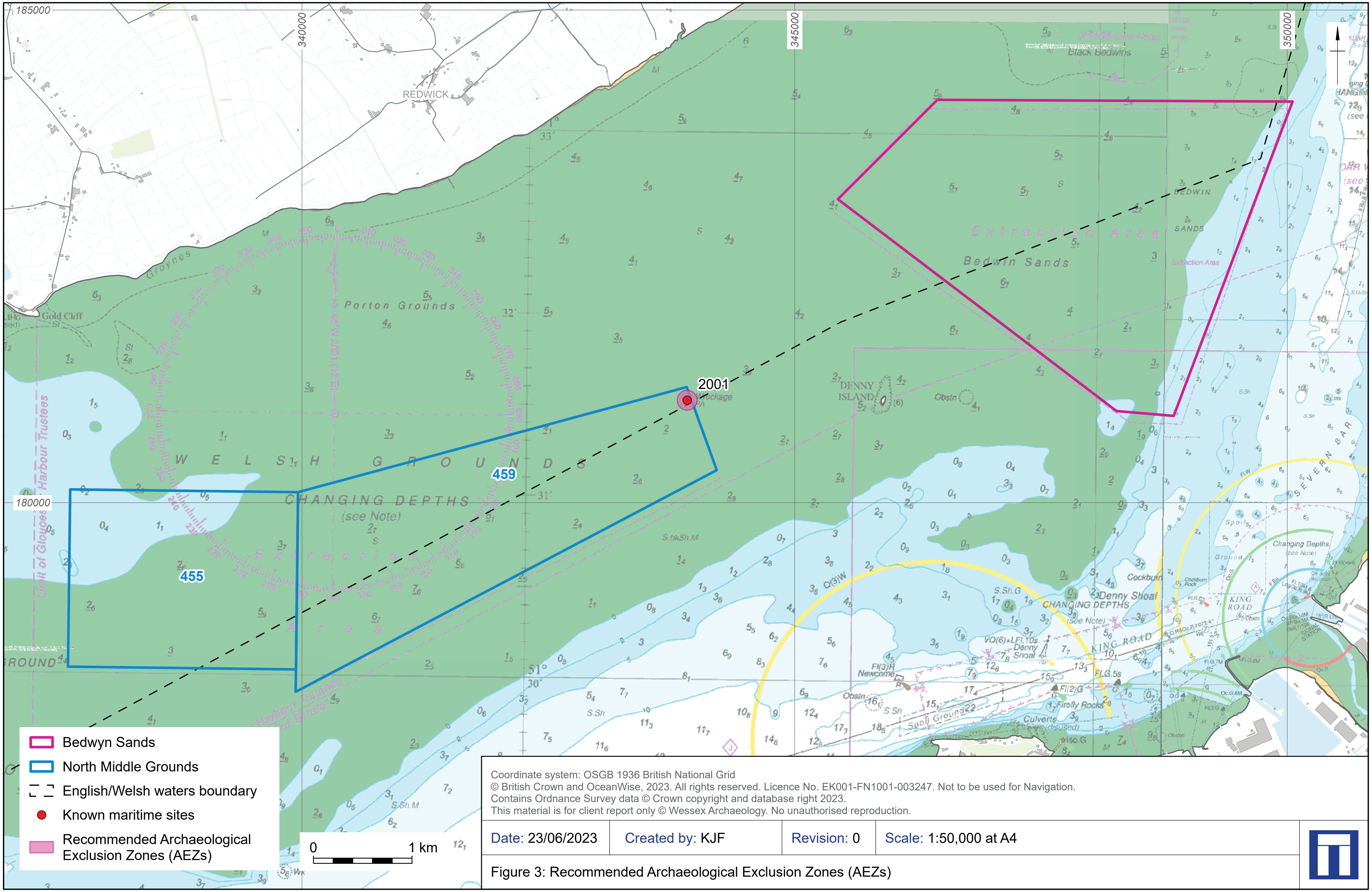

Coordinate system: OSGB 1936 British National Grid

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Figure 3: Recommended Archaeological Exclusion Zones (AEZs)

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