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CHAPTER 12: BENTHIC ECOLOGY

12. BENTHIC ECOLOGY

12.1 Introduction

This chapter presents an assessment of potential effects of the construction and operation of the Aberdeen Harbour Expansion Project on marine benthic habitat and associated biological communities (together termed biotopes) recorded within and peripheral to the proposed development at Nigg Bay. Baseline data were gathered through a detailed literature review and from site-specific sampling surveys, and were used to describe the biotopes and their extent within the wider geographical context.

The biotopes were subsequently assessed in terms to their ecological and conservation importance, and in relation to their predicted response to the impacts arising from the construction and operation of the development. The aim was to identify potential significant ecological effects associated with the development and any related possible mitigation measures. The assessment also took into account potential secondary impacts on the ecology of higher trophic communities which depend on the correct functioning of the biotopes identified (as presented in Chapter 13: Fish and Shellfish Ecology, Chapter 14: Marine Ornithology and Chapter 15: Marine Mammals).

This chapter is supported by and should be read in conjunction with, the following appendices:

- ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey;
- ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey;
- ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment;
- ES Appendix 7-B: Water Quality Modelling Assessment; and
- ES Appendix 7-D: Sediment Plume Modelling.

12.2 Policy, Legislation and Guidance

Chapter 4: Planning and Legislation presents the policies and legislation that regulate the proposed development, as well as the requirement to undertake an EIA and HRA. The relevant legislative frameworks governing benthic ecology are common to wider policies concerning ecology and nature conservation; these are addressed in detail in Chapter 10: Nature Conservation.

12.1.1 International Policy and Legislation

- United Nations Convention on Biological Diversity 1992 (the Rio Convention);
- Convention for the Protection of the Marine Environment of the north-east Atlantic 1992, (the OSPAR Convention);
- European Council Directive 92/43/EEC on the Conservation of Wild Fauna and Flora (the Habitats Directive);
- European Council Directive 2008/56/EC Establishing a Framework for Community Action in the Field of Marine Environmental Policy, (Marine Strategy Framework Directive - MSFD); and

- European Council Directive 2000/60/EC Establishing a Framework for Community Action in the Field of Water Policy (Water Framework Directive - WFD).

12.2.1 National Policy and Legislation

- The Wildlife and Countryside Act 1981 (WCA);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the Habitats Regulations);
- Nature Conservation (Scotland) Act 2004;
- Marine (Scotland) Act 2010;
- The Conservation of Habitats and Species Regulations 2010;
- The Infrastructure Planning (Decisions) Regulations 2010 (Infrastructure Planning Regulations);
- The Marine Strategy Regulations 2010 (the Marine Strategy Regulations);
- UK Post-2010 Biodiversity Framework (the successor to, Biodiversity: UK Action Plan 1994); and
- WFD related legislation - Water Environment and Water Services (Scotland) Act (WEWS) 2003; Water Environment (River Basin Management Planning: Further Provision) (Scotland) Regulations 2013; and the Cross-Border River Basin Districts (Scotland) Directions 2014.

12.2.2 Guidance

- Scottish Natural Heritage, Advice on Marine Planning, including management of Marine Protected Areas (Available on-line at: http://www.snh.gov.uk/planning-and-development/marine-planning/ Accessed March 2015);
- European Commission (2013) Interpretation Manual of European Union Habitats EUR 28 (European Commission, 2013) (Available on-line at: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf. Accessed March 2015);
- EU Biodiversity Strategy (Available on-line at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0244. Accessed March 2015);
- The identification of the main characteristics of stony reef habitats under the Habitats Directive (Irving 2009) (Available on-line at: http://jncc.defra.gov.uk/pdf/web432.pdf. Accessed March 2015);
- Marine Strategy Framework Directive (MSFD) consultation, Programme of Measures Department for Environment Food and Rural Affairs, 2015 (Available on-line at: https://consult.defra.gov.uk/marine/msfd-programme-of-measures/supporting_documents/20141015%20POM%20complete%20consultation%20document%20FINAL.pdf. Accessed March 2015);
- GB Non-Native Species Secretariat (NNSS) (Available on-line at: http://www.nonnativespecies.org/index.cfm?sectionid=22. Accessed March 2015);
- Alien Invasive Species and the Oil and Gas Industry – Guidance for prevention and management, OGP/IPIECA, 2010 (Available on line at: http://www.ogp.org.uk/pubs/436.pdf. Accessed March 2015);

- Scottish Natural Heritage advice on marine non-native species (Available on-line at: http://www.snh.gov.uk/land-and-sea/managing-coasts-and-sea/marine-nonnatives/ Accessed March 2015);
- The Green Blue Best Practice – Dealing With Invasive Species (Available at: http://www.thegreenblue.org.uk/clubs_and_training_centres/antifoul_and_invasive_species/best_practice_invasive_species.aspx Accessed March 2015); and
- Institute for Ecology and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland (Marine and Coastal) (IEEM, 2010).

12.3 Consultation

Table 12.1 presents the consultation that has been undertaken that is relevant to benthic ecology.

In addition to comments received as part of the EIA scoping stage (ES Appendix 1-D), consultation was undertaken with Marine Scotland, Scottish Natural Heritage (SNH) and the Scottish Environment Protection Agency (SEPA) on the survey methodologies for the baseline surveys. All surveys were undertaken in line with the agreed methodologies.

Table 12.1: Advice following consultation on the Scoping Report

Consultee	Correspondence Type	Date	Relevance	Comment	Where Addressed in ES
Marine Scotland (MS)	Letter	19 September 2013	Benthic Ecology	The ES must demonstrate consideration of the potential impacts of all species introductions.	This chapter, Section 12.7.4.1
				We welcome the inclusion of intertidal and subtidal surveys to provide a complete baseline understanding.	This chapter, Section 12.6.2.1 and 12.6.2.2.
				We note the intention to agree survey scope and methodology with Marine Scotland and look forward to these discussions. Such discussions should occur prior to surveys being carried out.	This chapter, Section 12.6.2.1 and 12.6.2.2
Scottish Natural Heritage (SNH)	Letter	20 August 2013	Marine Ecology – Benthic Intertidal and Subtidal	Care should be taken over identifying the presence and extent of any Priority Marine Features (PMFs). Grab samples are proposed but could potentially damage sensitive features. Grab sampling locations should be informed by the results of the geophysical survey and any visual surveys undertaken.	This chapter, Section 12.6.2.2
Scottish Environment Protection Agency (SEPA)	Letter	29 August 2013	River Basin Management Planning (RBMP)	Marine Non-Native Species (MNNS) into the adjacent water bodies to be included into ES and later, as part of the planning application within the Environmental Management Plan (EMP).	This chapter, Section 12.7.4.1

12.4 Methodology

General guidelines on the impact assessment methodology are presented in Chapter 5: Environmental Impact Assessment Process. This section presents a summary of the criteria used for the ecological impact assessment on the benthic habitats and associated biological communities (infauna and epifauna).

Of particular importance within the ES is the consideration of the value of ecological features, which is dependent on their biodiversity value within a geographic area. Some habitats and/or species have a specific biodiversity value recognised through international and national legislation or through local and national conservation plans. However, the evaluation of habitats and communities also takes into account the ecological value according to their functional role (e.g. they may be functionally linked to a feature of high conservation value, although they do not hold such value in themselves).

The assessment of potential effects arising from the development evaluates changes to baseline conditions above background environmental variations. The changes have been assessed based in part on model outputs of suspended sediment concentration, sediment deposition and scour evaluation.

In terms of benthic habitat, the effects arising from the development can be attributed directly to the physical presence of structures (breakwaters and quays) and dredging activities on the seabed and in the water column, and how this may alter the existing benthic habitat. This may occur via disturbance of and/or loss of natural habitat, introduction of new substrates from the presence of infrastructure, or by changes to the hydrodynamic regime that may, for example cause changes in suspended sediment load and sediment deposition.

12.4.1 Study Area

The study area encompasses benthic habitats and biological communities occurring within the boundaries of the Aberdeen Harbour Expansion Project. Habitats around the periphery of the development area, and within the predicted maximum tidal excursion over a single spring tide occasion based on Admiralty tidal diamond data, were also considered (relevant figures are provided in the Baseline Section 12.6).

12.4.2 Scope of the Assessment

The receptors that have been considered in this assessment include seabed habitats and the communities of plants and animal species typically associated with each habitat type. Collectively, these are termed biotopes. A biotope is defined as the combination of an abiotic habitat and its associated community of species, which can be defined at a variety of scales (with related corresponding degrees of similarity) and is a regularly occurring association (Connor et al., 2004).

The assessment also draws upon specific guidance and best practice as outlined in Section 12.2.

The following benthic ecology biotope receptors were considered for assessment:

12.4.2.1 Intertidal (IT)

IT Rocky Algal Dominated Biotopes

- **LR.LLR.F.Fves.FS** *Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock;
- **LR.MLR.BF.Fser.R** *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock;
- **LR.FLR.Eph.EphX** Ephemeral green and red sea weeds on variable salinity and/or disturbed eulittoral mixed substrata;
- **IR.MIR.KR.Ldig** *Laminaria digitata* on moderately exposed sublittoral fringe rock;
- **LR.LLR.F.Pel** *Pelvetia canaliculata* on sheltered littoral fringe rock;
- **LR.FLR.Eph.EntPor** *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock;
- **LR.HLR.FR.Mas** *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock;
- **LR.MLR.BF.FvesB** *Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock; and
- **LR.FLR.Rkp.Cor** Coralline crust-dominated shallow eulittoral rockpools.

IT Rocky Faunal Dominated Biotopes

- **LR.HLR.MusB.Sem.LitX** *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles;
- **LR.HLR.MusB.MytB** *Mytilus edulis* and barnacles on very exposed eulittoral rock; and
- **LR.HLR.MusB.Sem.Sem** *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock.

IT Sedimentary Biotopes

- **LS.LSa.MoSa** Barren or amphipod dominated mobile sands;
- **LS.LCS.Sh.BarSh** Barren littoral shingle; and
- **Ls.LSa.St.Tal** Talitrids on the upper shore and strandline.

IT Lichen Dominated Biotopes

- **LR.FLR.Lic.YG** Yellow and grey lichens on supralittoral rock;
- **LR.FLR.Lic.Ver.Ver** *Verrucaria maura* on exposed littoral fringe littoral rock; and
- **LR.FLR.Lic.Ver.B** *Verrucaria maura* and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock.

12.4.2.2 Subtidal (ST)

ST Rocky Algal Dominated Biotopes

- **IR.MIR.KR.Ldig** *Laminaria digitata* on moderately exposed sublittoral fringe rock.

ST Rocky Faunal Dominated Biotopes

- **Cr.MCR.EcCr** Echinoderms and crustose communities.

ST Sedimentary Biotopes

- **SS.SSa.IFiSa.NcirBat** *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand;
- **SS.SCS.ICS.Glap** *Glycera lapidum* in impoverished infralittoral mobile gravel and sand;
- **SS.SCS.ICS** infralittoral coarse sediments; and
- **SS.SSa.IMuSa.FfabMag** *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand.

Potential intertidal and subtidal Annex I habitats 'Reef', 'Sandbanks which are slightly covered by sea water all the time' and 'Mudflats and sandflats not covered by seawater at low tide' have been included in the assessment, along with the Biodiversity Action Plan (BAP) habitat 'subtidal sands and gravels'. Intertidal and subtidal biotopes of ecological and conservation interest have been detailed in Sections 12.6.2.1 and 12.6.2.2 (site-specific surveys).

12.4.3 Data Sources

Data used to form the baseline of benthic ecology are presented and discussed in detail in ES Appendices 12-B: Subtidal Benthic Ecological Characterisation Survey and 12-A: Intertidal Benthic Ecological Characterisation Survey. Data were collated through desk study and a site-specific benthic ecology survey with the subtidal work using surface grab samples, drop-down video and beam trawls to collect information on benthic habitats and species within and around Nigg Bay.

Desk-based data sources included academic and regulatory agency publications and websites of the statutory nature conservation bodies (e.g. Joint Nature Conservation Committee (JNCC), SNH, MS, Department of Trade and Industry (DTI), Department of Energy & Climate Change (DECC), SEPA, Mapping European Seabed Habitats (MESH Atlantic) and UK Biodiversity Action Plan (BAP)). In addition, publications and data from non-governmental organisations and international bodies were used, such as those from the International Union for Conservation of Nature (IUCN), the Marine Life Information Network (MarLIN) and the National Biodiversity Network (NBN).

In addition, Marine Scotland supplied towed video imagery from survey work undertaken in the wider area in July 2014.

12.5 Impact Assessment Methodology

This section explains the approach to identifying benthic ecological receptors, identifying impacts and impact pathways, defining effect magnitude and receptor value, and evaluating the significance of effects. The approach follows the general assessment methodology presented in Chapter 5: Environmental Impact Assessment Process including the magnitude and value factors, but uses tailored definitions to address relevant aspects of benthic ecology. The magnitude also considers the outputs of the sediment modelling (ES Appendix 7-D: Sediment Plume Modelling) and supports quantitative assessment of the effects of the project on benthic ecology.

12.5.1 Identification of Impacts

The impact assessment process starts with the identification of the impacts that are predicted to arise from the construction and operation of the development, based on the Project Description (see Chapter 3: Description of the Development) and the pathways through which those impacts are transmitted to receptors. Table 12.2 presents the potential construction and operational impacts of the scheme together with the pathways through which effects on benthic ecology may occur. In general, impacts were found to relate principally to the placement of infrastructure on the seabed and seabed disturbances.

Potential impacts arising from construction and operation of the harbour development include direct and indirect effect-pathways, which will result in direct and indirect effects on associated benthic ecological receptors.

The direct impacts identified are caused by physical changes to the environment and include:

- Habitat loss and disturbance (e.g. implications to benthic habitat loss and disturbance; change in nature of the seabed; and
- Displacement of reproductive faunal and floral populations and prey/food items).

Indirect impacts occur as a consequence of a direct impact and may be experienced spatially and temporally away from the source. As such, they acknowledge the wider ecosystem and trophic interactions between associated habitats, and include:

- Increase in SSC and associated turbidity (e.g. implications for filter feeders, visual predators) / contaminant release, subsequent sediment settlement and siltation or scour of benthic communities, and potential implications for survival and reproductive success;
- Changes in hydrodynamics and nutrient transport (e.g. structures can affect water flow and this may be critical to marine organisms since it influences larval recruitment, sedimentation rates, the availability of food and oxygen and the removal of waste); and
- Introduction of artificial substrate and non-native species (e.g. increase in habitat heterogeneity and biodiversity of sessile organisms, and potential to provide entry points and stepping-stones for non-native species brought in as larvae by, for example, ballast water, or indigenous species not naturally resident in the area, but facilitated by the presence of artificial substrate).

Inter-relationship impacts are changes which occur on a single receptor from multiple sources and pathways and may be additive, synergistic or antagonistic (e.g. displacement of species as a result of habitat disturbance or loss and smothering by increased SSC).

A key component to the assessment has been the application of peer-reviewed biological sensitivity data to various anthropogenic effects, including those associated with harbour infrastructure development (e.g. habitat physical disturbance, increased SSC). Literature and guidance, such as MarLIN, provide an overview of the sensitivity of benthic and aquatic marine life to the specific potential environmental impact of marine developments, based on field and experimental studies as well as theoretical models.

Table 12.2: Predicted impacts and associated pathways for effects on benthic ecology

Activity	Impact Transmission Pathway	Receptor	Description of Impact
Construction			
Dredging and seabed preparatory work	Physical seabed disturbance	Habitat and species	Temporary seabed disturbances disrupting habitats and associated species
	Increased suspended sediment concentrations (SSC)	Habitat and species	Temporary increases in SSC reducing light, clogging gills and feeding apparatus etc.
			Temporary increases in sediment deposition leading to smothering/burial and associated costs (e.g. mortality, energetic costs of repositioning)
	Release of sediment contaminants	Species	Water quality changes, increased bioavailability of sediment contaminants, potential impairment to individuals / populations
Piling, drilling and blasting	Increased levels of underwater noise/vibration	Species	Potential mortality and avoidance behaviour, susceptibility of sessile fauna
Construction vessel and plant activities	Accidental spills of oil and fuels etc. into the marine environment	Habitats and species	Accidental release of pollutants, specific effect(s) depend on material involved
Offshore disposal of dredged material	Disposal of material at a licenced disposal site	Habitat and species	Increased SSC, smothering and reduction in extent of 'original' seabed habitat and release of sediment contaminants
Operation			
Infrastructure foundations and scour material	Footprint on the seabed	Habitats	Reduction in extent of original seabed habitat.
	Colonisation	Species	Introduction of new seabed habitat. Change in biodiversity and exploitation of artificial habitat by Marine Non-Native Species (MNNS)
	Changes to hydrodynamic regime	Habitats and species	Localised increases in current speed around breakwaters, greater retention times of water in the bay
Vessel movements	Disturbance of seabed by propellers	Habitats and species	Temporary seabed disturbances
Maintenance dredging	Physical disturbance	Habitat and species	Temporary seabed disturbances
			Temporary increases in SSC
			Temporary increases in sediment deposition
			Temporary release of sediment contaminants
Offshore disposal of dredged material	Disposal of material at a licenced disposal site	Habitat and species	Increased SSC, smothering and reduction in extent of 'original' seabed habitat and release of sediment contaminants

The assessment of effect significance is a multi-staged process involving definitions of impact/effect magnitude and receptor's value. If mitigation is required, the residual effects are considered following mitigation.

12.5.2 Magnitude

The characterisation of magnitude is consistent with IEEM (2010) and relevant criteria listed in Chapter 5: Environmental Impact Assessment Process:

- **Spatial Extent:** the full geographic area of influence where the impact is noticeable against background variability;
- **Duration:** the temporal extent of the impact is noticeable against background variability;
- **Frequency:** how often the impact occurs (important in terms of habitats/species' ability to recover between impacts). The frequency will either be intermittent or continuous or occur within or across the construction and operation phases;
- **Sensitivity:** dependent on the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery. Quantification of sensitivity criteria is, in large part, based on the categorisations laid out by MarLIN (2015):
    - **Recoverability:** the ability of a habitat, community, or species (i.e. the components of a biotope) to return to a state close to that which existed before the activity or event caused change;
    - **Tolerance:** the susceptibility, or not, of a habitat, community or species (i.e. the components of a biotope) to sustain damage, or die, from an external factor. Or, the ability of a receptor to be either affected or unaffected (temporarily and/or permanently) by an effect. and
- **Ecological resilience:** defined as 'the ability of a system to absorb disturbances and still maintain structure and functions' (Planque et al., 2012). Resilience of a particular receptor is therefore defined here as its ability to survive, adapt and recover from disturbance such that a given population of a species or area of habitat is able to continue to exist at a given level, or continue to increase along an existing trend (Planque et al., 2012; IEEM., 2010). The definition used here is also consistent with Holling (1973) who defined resilience as a determination of "the persistence of relationships within a system" and as such was "a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist". As indicated, the applied sensitivity assessment is based on an assessment of both recoverability and tolerance and therefore resilience is embedded in the methodology as an integral part of the sensitivity analysis which feeds into the evaluation of magnitude.

Effect magnitude is categorised as Severe, Major, Moderate, Low or Negligible with the descriptive definitions presented in Table 12.3 and based on the factors identified in Chapter 5: Environmental Impact Assessment Process.

Table 12.3: Categories of magnitude of effect and definition

Effect Category	Definition
Severe	The effect is permanent and irreversible such that, within the lifetime of the project, conditions (habitats and species) required for the ecosystem to continue functioning in its characteristic form/structure have been completely lost. Recolonisation/re-establishment of species/habitats previously present and the ecological processes that sustained them have been impaired such that no recovery to baseline conditions is possible. This effect occurs beyond the study area and impacts regional conditions.
Major	The effect is long term (beyond ten years) or permanent with the integrity of a biotope predicted to be affected across much of its distribution within the affected area. This is reflected by a significant shift in baseline conditions, including loss of characterising species and ecosystem function, in some instances extending beyond the immediate study area. Recoverability is possible, but not guaranteed, beyond ten years.
Moderate	The effect is medium to long term (5 years to 10 years) with the integrity of a biotope predicted to be affected and may manifest in a significant shift in baseline conditions, including change in the distribution and abundance of characterising and keystone species and biotopes within the study area. The wider area/region is largely unaffected. Recovery in the long term (within, or beyond, 10 years).
Minor	A change in baseline conditions is predicted in the short to medium term (1 year to 5 years) but the distribution of characterising and keystone species will be largely unaffected and occurs at local or site specific scale with some temporary displacement to adjacent non-affected areas. The wider area/region are unaffected. Recovery likely within 1 year to 5 years and certainly within 10 years.
Negligible	Changes to baseline conditions are largely expected to be undetectable / measurable against natural variation beyond the footprint of activity. Recovery would, in any case, occur within 1 year.

12.5.3 Value of the Receptor

The value of benthic ecology receptors has been assigned according to whether the habitats and species have been assigned any local, national or international importance. The valuation of sites makes use of established conservation value systems as detailed in Chapter 10: Nature Conservation (summarised in Table 12.4).

Table 12.4: Examples of criteria used to evaluate ecology receptors

Level of Value	Examples of Definitions
International	Special Areas of Conservation (SACs)
	OSPAR threatened habitats and species
National (Scotland)	Nature Conservation Marine Protected Areas (NCMPAs)
	Priority Marine Features (PMFs)
National (UK)	Sites of Special Scientific Interest (SSSIs)
	Biodiversity Action Plan (BAP) Habitats and Species
	National Nature Reserves (NNR)
Local	Local Biodiversity Action Plans
	Local Nature Reserves (LNR)
	Local Nature Conservation Sites (LNCS)

Correlation between those biotopes identified as present and habitats listed for protection has been provided in Section 12.6.2.1 and Section 12.6.2.2, and is based on JNCC (2014).

Table 12.5 presents the different value categories and associated definitions used in the assessment for benthic ecology receptors.

Table 12.5: Categories of receptor value and associated criteria

Receptor Value	Definition
Very High	The receptor is protected by international law and is a qualifying feature of a Natura 2000 or OSPAR designation.
High	The receptor is protected by national law, is important for national biodiversity and is subject to a species/habitat action plan.
Medium	The receptor is locally or nationally important for nature conservation, contributes to the selection of Scottish MPAs and/or helps maintain the viability of the wider ecosystem.
Low	The receptor is part of a local nature conservation designation and whilst not considered to have a key ecosystem role is nevertheless a component part of a healthy and productive broader ecosystem.
Negligible	The feature is commonly occurring and widespread throughout the UK and is not recognised through any nature conservation designation mechanisms.

12.5.4 Assessment of Significance of Effects

The significance of an effect is assessed as ‘severe’, ‘major’, ‘moderate’, ‘minor’ or ‘negligible’ by combining the magnitude classification with receptor value classification using the matrix presented in Chapter 5: Environmental Impact Assessment Process.

12.5.5 Uncertainty

The uncertainty associated with the assessment is described as Low, Medium, or High based upon the availability and quality of data sources used to underpin the assessment conclusions. Low uncertainty indicates that receptor responses to specified effect are well studied, and interactions are well understood (this corresponds to the IEEM (2010) ‘Certain/near-Certain’ confidence level); medium uncertainty indicates receptor responses to the specified effect are documented, and interactions are understood (corresponding to the IEEM (2010) ‘Probable’ confidence level); and high uncertainty indicates receptor responses to specified effects are not well studied, and interactions are poorly understood (corresponding to the IEEM (2010) ‘Unlikely’ confidence level).

12.5.6 Cumulative Assessment Methodology

Potential cumulative effects on benthic ecology receptors have been identified and assessed following the methodologies presented in Chapter 5: Environmental Impact Assessment Process. Relevant projects and activities taken forward for cumulative assessment on benthic ecology are identified in Section 12.7.6.

12.6 Baseline

This section presents an overview of the marine benthic habitats and biological communities that are characteristic of Nigg Bay and the wider geographical area encompassing the east Scottish coastline. The related physical characteristics of the area are presented in Chapter 6: Marine Physical Environment.

The site-specific intertidal and subtidal surveys provide the basis for the detailed description of the existing benthic habitats within the proposed development study area. The full technical reports are provided in ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey and ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey.

12.6.1 Literature Review

12.6.1.1 Intertidal

The intertidal area within Nigg Bay has, according to Bennet and McLeod (1998), been used by students of the University of Aberdeen for investigations of individual species. Searches have not identified any published peer-reviewed literature from this and therefore it has not been sourced for the current work. However, Bennet and McLeod (1998) quote Hart (1971), who found that the intertidal macrofauna of Aberdeen Beach was dominated by the spionid *Nerine* (now *Scolelepis*) sp. and the amphipod *Haustorius arenarius*. However, in general, no published records of Nigg Bay site-specific benthic survey data were found during the literature review, the available literature making reference to the wider Aberdeenshire coast.

The Aberdeen Institute for Coastal Science and Management (AICSM, 2009) describe the littoral zone of Nigg Bay as an area of sandy beach, the intertidal zone of which includes areas of both natural boulders and re-worked building material, such as concrete slabs, bricks and masonry. This substantial volume of material appeared to have been either dumped directly on the foreshore, or eroded from the south area of the coastline where vast quantities of material had been dumped, possibly in the 1970s or earlier, partly as a protective barrier to coastal erosion.

Bennet and McLeod (1998) noted that the north-east coastline is '*predominantly rocky with extensive intertidal sediment areas occurring mainly within the inlets*', with '*numerous, often extensive, bays and sandy beaches*'. The fauna on these east Scottish beaches fall into three main invertebrate groups: polychaetes, crustaceans and molluscs. In general, the upper foreshore is inhabited mainly by the crustaceans such as *Talitrus saltator* and *Bathyporeia pilosa*. The middle and lower reaches are characterised by crustaceans such as *Eurydice pulchra*, *Haustorius arenarius*, *Bathyporeia pelagica* and *B. sarsi*, along with the polychaetes *Paraonis fulgens*, *Eteone longa*, *Ophelia rathkei* and *Scolelepis squamata*. The lower foreshores host most of the fauna of polychaetes (*Spio filicornis*, *Nephtys cirrosa*, *Spiophanes bombyx* and *Lanice conchilega*), crustaceans (*Bathyporeia elegans*, *B. guilliamsoniana*, *Pontoccrates altamarinus*, *P. arenarius*, *Atylus swammerdami* and *Pseudocuma gilsoni*) and bivalves (*Tellina tenius* and *Donax vittatus*) (Eleftheriou and Robertson, 1988).

The intertidal areas vary both in length and breadth, and consist mostly of unconsolidated sediment of different grades which vary from coarse to fine sand, depending on the degree of exposure and their geological history (Eleftheriou et al., 2004). Both groups of beaches include the same faunal elements, though in different numerical proportions (except for selected crustaceans, which are confined to sheltered conditions) and are representative of beaches of the Scottish coast (Eleftheriou and Robertson, 1988) from the Moray Firth to the Firth of Forth (Eleftheriou et al., 2004).

Overall, the intertidal fauna is considered a variation of the north-temperate water community, characterised by the bivalve *Tellina tenuis*, polychaetes and crustaceans, the richness of which is controlled by exposure. Thus, extreme exposure limits species richness by eliminating or restricting the sedentary forms of many bivalves and polychaetes, favouring the presence of fast swimmer crustaceans (Eleftheriou et al., 2004). Aberdeenshire and Angus, beaches are an example of this hosting a fauna characteristically dominated by the amphipods *Haustorius arenarius* and *Bathyporeia pelagica* and in some cases the spionid polychaete *Scolelepis (Scolelepis) squamata* (formerly *Nerine cirratulus*) (Bennet and McLeod, 1998; Eleftheriou et al., 2004). Conversely, sheltered sandy beaches host a rich and varied fauna including the above faunal elements but dominated by bivalves such as *Angulus (Tellina) tenuis* and *Donax vittatus*, the polychaetes *Nephtys cirrosa*, *Spio filicornis*, *Scolelepis squamata* and the cumaceans *Bodotria pulchella* and *Cumopsis goodsiri*. In addition, on beaches with a flattish profile and a high retention of seawater there was evidence of an incursion of subtidal species well into the intertidal, such as *Tellina fabula*, as well as the amphipod *Bathyporeia guilliamsoniana*, mysids, the polychaete *Nephtys hombergii* and several cumaceans (Eleftheriou and Robertson, 1988).

12.6.1.2 Subtidal

A comprehensive benthic ecological desk review commissioned by the Department of Trade and Industry (DTi) to inform appraisal of the effects of oil and gas leasing found that benthic communities in deeper water in the northern North Sea (Area 5) tend to be spatially distributed over large scales, with distinctive species assemblages associated with particular substrate types and present over large areas of the North Sea (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/195060/SEA5_Section_6.pdf).

In general, the review showed that sublittoral communities of the east Scottish coastline comprise northern species (e.g. the hydroids *Thuiaria thuja* and *Tamarisca tamarisca*; the anemone *Bolocera tuediae*; the algae *Callophyllis cristata*, *Odonthalia dentata*, *Phyllophora truncata*, *Ptilota plumosa* and *Rhodomela lycopodioides*; and the bryozoan *Bugula purpuropincta*) as well as southern species (e.g. the red algae *Schottera nicaeensis* and *Rhodymenia pseudopalmata*) often at the edge of their geographical distribution. Brittle stars, encrusting Corallinaceae, the soft coral *Alcyonium digitatum*, the polychaete *Pomatoceros* sp. and the dominant sea urchin *Echinus esculentus* are generally associated with kelp forests (Eleftheriou et al., 2004). The burrowing crab *Corystes cassivelaunus*, together with a number of bivalve species such as *Musculus discors*, *Hiatella arctica* and *Kellia suborbicularis* are found in cryptic habitats, while at the lowest level of the intertidal beaches small numbers of sublittoral species of bivalves such as *Ensis siliqua*, *Chamelea gallina* (now understood to be *Chamelea striatula*, Backeljau *et al*., (1994)) and *Mactra stultorum* are also present. Beyond the kelp forest unconsolidated material ranging from cobbles, boulders and molluscan shell fragments form a shell gravel habitat which hosts molluscs and polychaetes characteristic of such substratum (Eleftheriou et al., 2004).

During their review of the physical, biological and heritage characteristics of the coast and seas of the UK, the Joint Nature Conservation Committee's (JNCC) Marine Nature Conservation Review (MNCR) team divided the coast into several discrete sectors. The current Nigg Bay study area falls into sector 3. The MNCR identified two distinct infaunal groups which characterise the sublittoral infaunal communities of sandy seabeds. These include a shallower, less silty group, characterised by polychaete, *Spiophanes bombyx*, and a deeper siltier group characterised by amphipod, *Eriopisa elongata*, lamellibranchs, *Thyasira.* Areas off Aberdeen and St Andrews have fairly uniform deposits varying from muddy to fine sand, with those of the Aberdeen areas being slightly coarser. The fauna in the two areas is dominated by bivalve molluscs and polychaete worms, and is reported to be richer off Aberdeen (Bennet and McLeod, 1998).

There is no detailed published information specifically on the benthic communities of Nigg Bay, but the predicted habitat based on the UK SeaMap 2010 data available at the National Marine Plan Interactive website run by Marine Scotland suggests the presence of extensive areas of sand or muddy sand inshore along much of the coast (Figure 12.1). In particular there is an initial band of EUNIS Level 4 Habitats A5.23 Infralittoral fine sand or A5.24 Infralittoral muddy sand close inshore (this being broader to the north of Aberdeen than to the south including Nigg Bay).

Within Nigg Bay there is a small discrete patch considered to be a high energy expression of this habitat whilst immediately offshore of this area the same habitat is registered as moderate energy (Figure 12.1). The measure of energy is a combination of that from both wave and tidal sources (with the former more dominant in shallow inshore areas). These complex hydrological interactions are important factors that help define the stability of the seabed and hence shape the nature of the biological communities able to flourish there (JNCC, 2015a). A manifestation of the higher energy area is seen in the area of sand waves identified just outside Nigg Bay in the sidescan sonar survey (Caledonia Geotech, 2012).

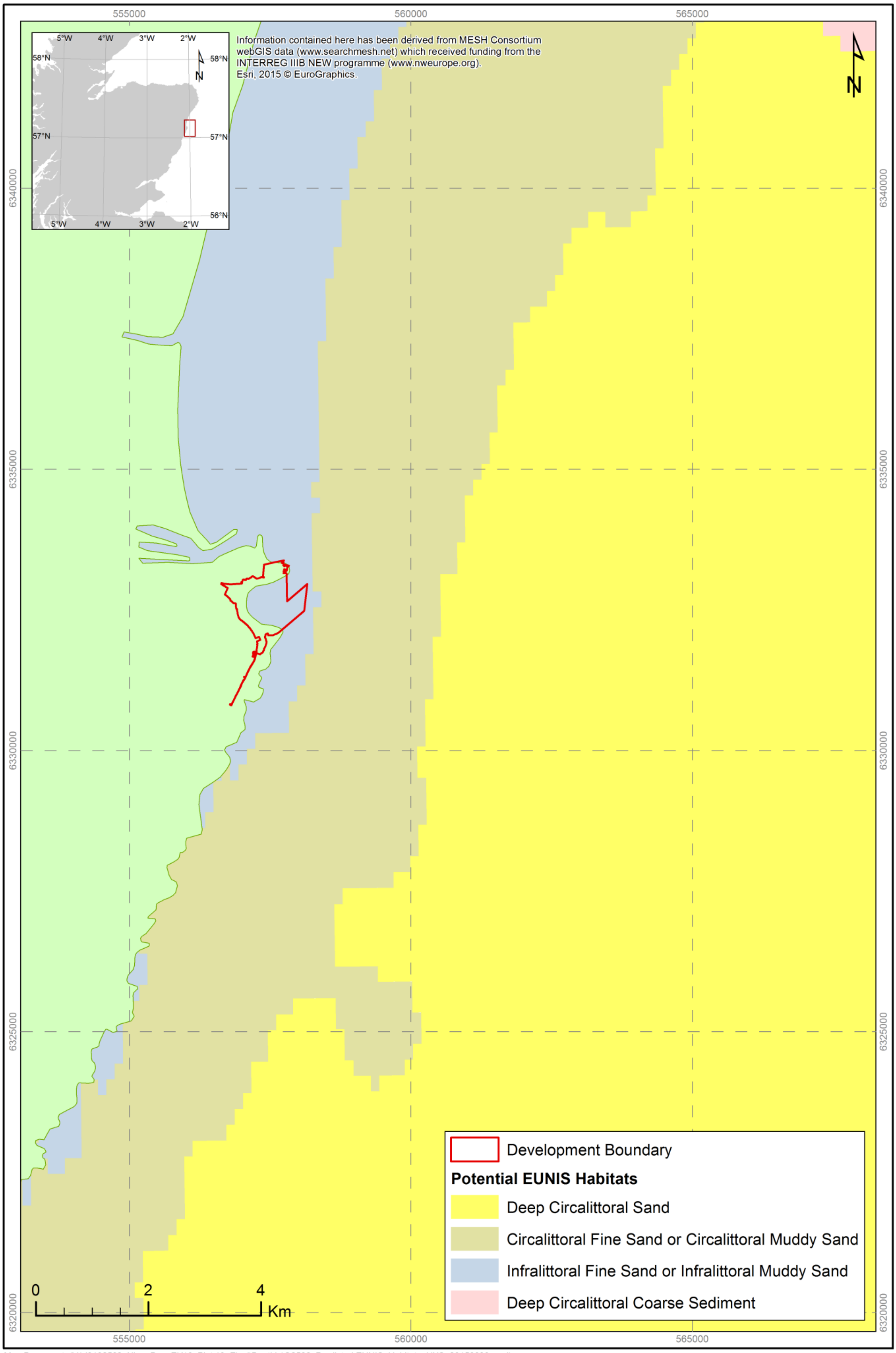

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Figure 12.1: Predicted EUNIS habitats offshore from Nigg Bay (UK SeaMap 2010)

Further offshore the predicted habitat becomes A5.25 circalittoral fine sand or A5.26 circalittoral muddy sand followed by A5.45 deep circalittoral mixed sediments, although small areas of both A5.44 circalittoral mixed sediments and A5.37 deep circalittoral mud are also predicted (Figure 12.1). Further offshore still (beyond approximately 9 km) the deep circalittoral mixed sediments are replaced by A5.27 deep circalittoral sand and then roughly 17 km offshore the predicted habitat becomes A5.15 deep circalittoral coarse sediment (Figure 12.1).

The presence of moderate energy infralittoral rock (A3.2 Atlantic and Mediterranean moderate energy infralittoral rock) is also predicted coastally, in particular for Greg Ness, the southerly headland for Nigg Bay (Figure 12.1). The infralittoral rock habitat of Girdle Ness is not mapped by the predictive layer.

Don Estuary to Souter Head – Water Framework Directive surveys

The RBMP water body relevant to the area of Nigg Bay in North East Scotland is the Don Estuary to Souter Head (Aberdeen) (Code 200105) (SEPA 2015a). This water body covers an area of 50.24 km^2 and encompasses both Nigg Bay and the existing disposal site (CR110) offshore. Classification results for benthic invertebrates based on the Infaunal Quality Index (IQI) indicate that this water body has scored ‘Good’ every year between 2007 and 2012 with a ‘High’ score in 2013 (the most recent available result). The overall status, based on a range of parameters largely focused on water quality, similarly showed the Don Estuary to Souter Head site to score ‘Good’ between 2007 and 2012 but then ‘Poor’ in 2013 (SEPA 2015b).

Long Sea Outfall Surveys

Slightly offshore from Nigg Bay, Day grab surveys in support of the Nigg Bay long sea sewage outfall have been carried out in 1988, 1991, 1995 and 2002 (Cranmer, 1989; Cunningham, 1991; Cunningham and Bell, 1996; SEPA, 2002). The centroid used to mark the diffuser at the end of the outfall and to chart the survey positions is approximately 1.5 km off Greg Ness. Locations surveyed around the outfall have varied slightly over the years, but in the main have used two or three 0.1 m^2 replicate Day grab samples sieved over a 1 mm mesh, from each of a number of stations close to the sewage outfall, and extending several km up and down current. In addition a number of stations were located inshore and offshore of the outfall, with a few of the stations inshore of the outfall being at a similar distance offshore to the most offshore stations used in the site-specific subtidal survey for this development. The depths at the stations surveyed were typically around 25 m to 35 m.

The sediments were found to be primarily very well sorted fine to medium (and sometimes coarse), sands with very low gravel and mud content, and with a low total organic content (almost always less than 2% as determined by loss on ignition). The taxa found were generally typical of sandy sediments in the area, and comprised mainly annelid worms, molluscs and amphipods. Of the polychaetes, *Nephtys* spp., *Ophelia borealis* and *Glycera* spp. were all present at all the stations. Several very small species of polychaete (*Pisione remota*, *Exogone* spp., *Hesionura elongata*) were also recorded in moderate numbers at many of the stations, but were reduced or absent at the most offshore stations. The most common taxon was the oligochaete worm *Grania* sp. The reef forming polychaete *Sabellaria spinulosa* was recorded at a few stations, scattered throughout the survey area, although they were never present in large numbers. Crustacea were not generally very abundant in the area, with only the burrowing amphipods *Bathyporeia guilliamsoniana* and *Atylus falcatus* (now *Nototropis falcatus*) being recorded with any frequency. These are again common taxa for clean sandy substrates, which do not usually support large numbers of crustacea.

The most common mollusc was the tellin bivalve *Moerella pygmaea*; other common bivalves included *Crenella decussata* and *Abra prismatica*. In 2002, the number of taxa and individuals per station (based on three replicates pooled in each case) were 14 to 95 (but mostly 24 to 54) and 58 to 1,355 respectively. It was concluded after the 2002 survey that the survey series had not shown any detrimental effect of the outfall, with the possible exception of a slight increase in numbers of small polychaetes close to the outfall (but no measurable associated enrichment of the sediment that would account for this).

Geophysical Surveys

Sidescan sonar and swathe bathymetry images of Nigg Bay and adjacent seabed from a geophysical survey carried out in August 2012 (Caledonia Geotech, 2012) were used as an aid to both planning and reporting the subtidal site specific benthic ecology survey work (12.6.2.2). Both of these sources suggest the majority of the seabed is likely to be sandy but with a fringe of subtidal rock, somewhat variable in extent, representing an extension of the intertidal bedrock and boulder habitats (see also CMACS, 2014). In some places the rock/sand boundary appeared to be very sharp, but in others (e.g. to the east of Girdle Ness at the northern end of Nigg Bay) it was much less so. Three surface sediment samples taken by Caledonia Geotech (2012) with a Van veen grab showed the sediment to be well sorted medium, or fine to medium, sands with 0.1% to 4.2% mud content and almost no gravel content. The sediment, which according to borehole information consists of a mixture of sand, silt, gravel and cobbles, overlies rock and is up to 30 m thick in the centre of the Bay.

Marine Scotland – Kincardine Surveys

In 2014 video tows and sediment samples were taken by MS at a variety of locations, including just offshore from Nigg Bay, in order to provide habitat information for potential developers (Mike Robertson, MS; pers. comm). These samples have not been worked up by Marine Scotland as yet but two video records have been made available and analysed by Fugro EMU. The site within the offshore disposal site is TV32, and the site roughly 0.5 km south of the disposal site boundary is TV31.

<u>Sedimentary Environment</u>

The video quality is relatively poor, hampering identification. That said, both sites appear to be largely comprised of muddy-sand with small irregular ripples marking the surface. TV31, outside the disposal site, is clearly slightly gravelly in nature with shell fragments in evidence, within the troughs, throughout the tow. This gravel component is less evident in TV32 with the troughs harbouring a fine flocculent material. This flocculent material is also present from TV31 but to a lesser degree. In addition, TV31 possesses periodic grey patches/surface scars where it appears the anoxic surface layers have been disturbed to reveal the more anoxic environment beneath. Similar patches are not seen in TV32. Both tows have occasional rock/boulders outcropping from the muddy-sand with more in evidence in TV32, in particular in the latter half of the tow.

<u>TV31</u>

Species recorded in the video include the following:

- Greater pipefish (*Syngnathus acus*), single specimen near the start of the tow;
- Edible crab (*Cancer pagurus*), single specimen, partially buried in the sediment;
- Seven-armed starfish (*Luidia ciliaris*), single specimen;
- Dead man's fingers (*Alcyonium digitatum*), a couple of isolated small clusters;
- European lobster (*Homarus gammarus*), single specimen, sheltering beneath large artificial rectangular block;
- Gurnard (Triglidae), single specimen; and
- Hydroid / bryozoan turf in evidence on outcropping boulders.

<u>TV32</u>

The video taken on this tow showed that there were very few species visible at this location (though this may in part be attributable to the poor quality nature of the video). Species recorded include:

- Hydroid/bryozoan turf in evidence on outcropping boulders;
- Possible common starfish (?*Asterias rubens*), single potential sighting;
- Possible fish, single potential sighting; and
- Dead man's fingers (*Alcyonium digitatum*), single isolated small cluster.

European Offshore Wind Deployment Centre

The site of the proposed European Offshore Wind Deployment Centre (EOWDC) is located to the north of Aberdeen between 8 km and 14 km from Nigg Bay. Here in 2010, surveys 1 km to 5 km offshore in depths ranging from 5 m to around 40 m found that the sediments were predominantly sands, with less than 2% mud content inshore, but increasing up to c. 14% mud offshore (CMACS, 2011).

Low numbers of species and abundance were found in the infaunal community of the very sandy inshore shallower stations, where the polychaetes *Nephtys cirrosa* and amphipods dominated, matching the biotope **SS.SSA.IFiSa.NcirBat** (*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand). The majority of stations were further offshore, where higher numbers of species and abundance were present with the polychaetes *Notomastus latericeus*, the bivalves *Nucula nitidosa* and *Tellina fabula* and brittle stars *Ophiura* spp. dominating, and matching the biotope SS.SSA.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment. Also dominant were the polychaetes *S. bombyx*, *Galathowenia oculata*, *Pholoe baltica*, *N. cirrosa* and *Nephtys assimilis*.

Other dominant molluscs recorded included *Kurtiella bidentata* and *A. alba*. The most abundant crustaceans were the amphipods, such as *B. guilliamsoniana* and *Ampelisca brevicornis*. Other groups accounted for less than 7% of the total faunal abundance. The invertebrate epifaunal community was sparse, consisting mainly of brittle stars, brown shrimp (*Crangon crangon*) and flying crab (*Liocarcinus holsatus*).

McIntyre 1958

McIntyre (1958) described the benthos of the east coast fishing grounds with reference to surveys of Aberdeen Bay. McIntyre's survey location is just under 4 km south of the much more recent work undertaken for the EOWDC site. Although the temporal distance is large (greater than 50 years) the two sets of results are very similar. McIntyre found the benthic fauna to be dominated by lamellibranchs and polychaetes. For the former, *Abra alba*, *Tellina fabula*, *Nucula turgida* (the status of this taxon is currently in question, therefore *Nucula* sp. is more appropriate here) and *Ensis* sp. were dominant. For the latter, the polychaetes *Lanice conchilega*, *Sigalion mathildae*, *Notomastus latericeus* and *Nephtys* sp. were also abundant.

12.6.2 Site-specific Surveys

The site-specific intertidal and subtidal surveys were undertaken in October 2014 and March 2015, respectively; further details are presented in ES Appendices 12-B: Subtidal Benthic Ecological Characterisation Survey and 12-A: Intertidal Benthic Ecological Characterisation Survey. The methodology and results are briefly summarised and discussed in this section, particularly with regard to their ecological and conservation importance.

12.6.2.1 <u>Intertidal Survey</u>

The site-specific survey area encompassed the region from the splash/lichen zone (supra-littoral) to the sublittoral fringe, within an area extending from Girdle Ness in the north to Greg Ness in the north and south of Nigg Bay.

Methodology

The survey methodology was based on technical guidance from the JNCC (2010; 2006) for undertaking a Phase 1 habitat survey. Further details describing the survey methodology can be found in ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey.

Results

The biotope map generated from the intertidal survey work is provided in Figure 12.2.

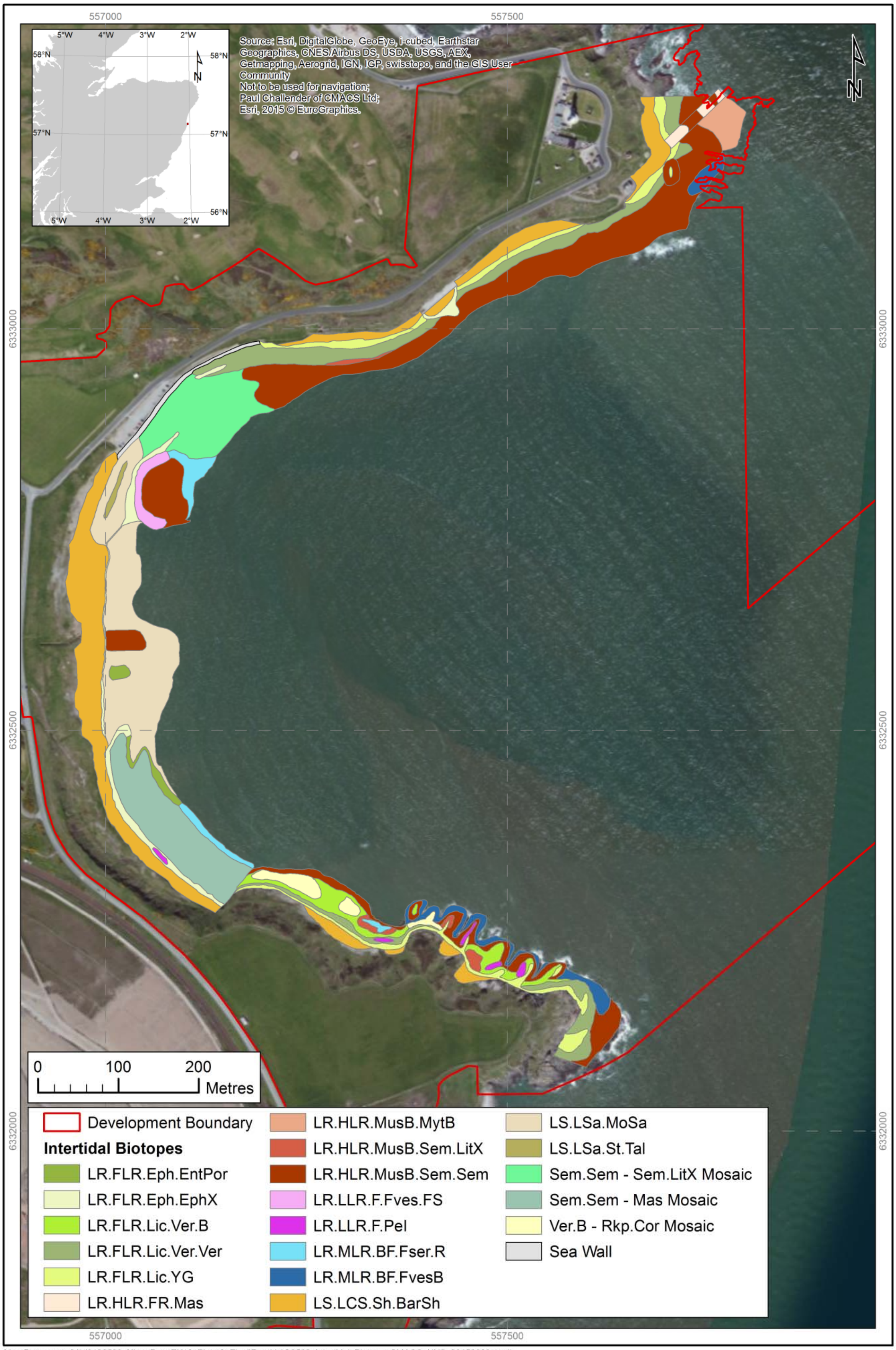

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Figure 12.2: Intertidal biotope map, Nigg Bay survey, October 2014

The upper shore of the central area of Nigg Bay was dominated by barren gravels shingle, cobble and boulder (**LS.LCS.Sh.BarSh**: Barren littoral shingle), often mixed with sediment of anthropogenic nature such as rubble, broken concrete and patches of broken tarmac. Lichen dominated communities (**LR.FLR.Lic.YG**: Yellow and grey lichens on supralittoral rock; **LR.FLR.Lic.Ver.Ver**: *Verrucaria maura* on exposed littoral fringe littoral rock; and **LR.FLR.Lic.Ver.B**: *Verrucaria maura* and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock) were common at Girdle and Greg Ness, together with patches of cobbles and boulders. Much of the central area of the bay was characterised by mobile sands (**LS.LSa.MoSa**: Barren or amphipod dominated mobile sands), either barren or with little fauna.

At mid shore, the bay was dominated by biotopes characterised by barnacles (**LR.HLR.MusB.Sem.Sem**: *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock), often mixed with fucoid algae (**LR.MLR.BF.FvesB**: *Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock), periwinkles (**LR.HLR.MusB.Sem.LitX**: *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles) and/or lichen dominated rock (**LR.FLR.Lic.Ver.B)**.

Unstable cobble and boulders often hosted ephemeral green and red algae (**LR.FLR.Eph.EphX** Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata and **LR.FLR.Eph.Eph.EntPor** "*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock"), usually occurring in narrow bands mostly in the more central parts of the bay.

Larger boulders provided suitable habitat for red algae such as *Mastocarpus stellatus* and *Chondrus crispus* (**LR.HLR.FR.Mas**: *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock), which occurred also on the headlands bedrock. At sheltered locations, bedrock was colonised by *Fucus vesiculosus* (**LR.MLR.BF.FvesB**: *Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock) which became dominant with increased degree of shelter (**LR.LLR.F.Fves.FS**: *Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock). This biotope was extensive on the steep faces of the rocky cliff along the southern shoreline.

At the northern and southern shorelines of the bay, the lower shore was characterised by patches of dense growths of *Fucus serratus* and *Palmaria palmata* with other red seaweeds (**LR.MLR.BF.Fser.R** *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock), whereas the lower edge hosted a more continuous biotope dominated by kelp (**IR.MIR.KR.Ldig** *Laminaria digitata* on moderately exposed sublittoral fringe rock). Two variants of this biotope were recorded, to include *L. digitata* forest on rocky shores (**Ldig.Ldig**), and *L. digitata* on boulder shores (**Ldig.Bo**), the former being more prevalent at the headlands, particularly to the south, the latter more characteristic of the bay and the northern shore.

The biotope **LR.LLR.F.Pel** (*Pelvetia canaliculata* on sheltered littoral fringe rock) occurred in patches on the sloping concrete seawall and on the upper band of large boulders; whereas the biotope **LR.FLR.Rkp.Cor (**Coralline crust-dominated shallow eulittoral rockpools) occurred in shallow rockpools.

Intertidal Biotopes of Ecological and Conservation Interest

None of the biotopes recorded from the intertidal survey are component parts of any of the currently identified Scottish Priority Marine Features (PMFs). Similarly, none of the species recorded are identified as PMFs.

Based on the JNCC (2014) marine habitat correlation table many of the biotopes recorded may occur in the Annex I habitat, Reefs (Table 12.6). However, as noted by the JNCC (2014), in order to satisfy the linkage there must be some connection to sublittoral rock (EUNIS Codes A3/A4). In fact, the Interpretation Manual of European Union Habitats - EUR28 (2013) supplies the following definition for Annex I Reef habitat:

"*Sublittoral and littoral zone" means: the reefs may extend from the sublittoral uninterrupted into the intertidal (littoral) zone or may only occur in the sublittoral zone, including deep water areas such as the bathyal.*"

This suggests that any littoral biotope which might form part of an Annex I Reef would need to have an uninterrupted connection to the sublittoral zone. CMACS, who undertook the intertidal survey work, have confirmed that much, if not all, of the intertidal rock areas along both the north and south shores (i.e. not just the headlands) could be described as having such an 'uninterrupted' connectivity.

The **LS.LSa.MoSa** biotope can occur in the Annex I habitat 'Mudflats and sandflats not covered by seawater at low tide' (Table 12.6).

The littoral sediment biotopes **LS.LCS.Sh.BarSh** and **LS.LSa.St.Tal** are not linked to any protected marine Annex I or other habitats.

No designated SAC or Area of Search for possible future SACs with respect to either 'Reef' or 'Mudflats and sandflats not covered by seawater at low tide' features exists in Nigg Bay or the wider region (see Chapter 10: Nature Conservation).

None of the invertebrate species encountered are listed on the Scottish Biodiversity list (2013). One habitat of possible relevance was 'Intertidal boulder communities', which has no specific biotope code but does have two codes associated with it (UK BAP 2008a). These are **LR.MLR.BF.Fser.Bo** - *Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders; and, **IR.MIR.KR.Ldig.Bo** - *Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders (UK BAP 2008a). Neither of these were found during the site specific survey work (ES Appendix 12-A Intertidal Benthic Ecological Characterisation Survey). Other biotopes which occur on boulders on the mid to lower shore can also be associated with the habitat (UK BAP, 2008a). Boulders with a limited under boulder community are not included in this UK BAP (UK BAP, 2008a). The boulders encountered in Nigg Bay were both sand scoured in places and unstable and therefore under boulder communities were not identified. The habitat can also occur within Annex I Reefs.

Table 12.6: Correlation between recorded intertidal biotopes and Annex I features

Code	Description	Relation to Annex I 'Habitat' Types	Annex I
LR.HLR.MusB.Sem.Sem	*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	< May occur*	Reefs
LR.LLR.F.Fves.FS^	*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock	< May occur*	Reefs
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	< May occur*	Reefs
LR.FLR.Eph.EphX	Ephemeral green and red sea weeds on variable salinity and/or disturbed eulittoral mixed substrata	< May occur	Reefs
IR.MIR.KR.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock	<	Reefs
LS.LSa.MoSa	Barren or amphipod dominated mobile sands	<	Mudflats and sandflats not covered by seawater at low tide
LS.LCS.Sh.BarSh	Barren littoral shingle	-	-
LS.LSa.St.Tal	Talitrids on the upper shore and strandline	-	-
LR.LLR.F.Pel^	*Pelvetia canaliculata* on sheltered littoral fringe rock	< May occur*	Reefs
LR.FLR.Eph.EntPor	*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock	< May occur*	Reefs
LR.FLR.Lic.YG	Yellow and grey lichens on supralittoral rock	<	Reefs
LR.HLR.FR.Mas	*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock	< May occur*	Reefs
LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock	< May occur*	Reefs
LR.HLR.MusB.Sem.LitX	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles	< May occur*	Reefs
LR.HLR.MusB.MytB	*Mytilus edulis* and barnacles on very exposed eulittoral rock	< May occur*	Reefs
LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on exposed littoral fringe littoral rock	<	Reefs
LR.FLR.Lic.Ver.B	*Verrucaria maura* and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock	<	Reefs
LR.FLR.Rkp.Cor	Coralline crust-dominated shallow eulittoral rockpools	< May occur*	Reefs

Notes:
* If connected to sublittoral rock (EUNIS Codes A3/A4)
^ Typical of Annex I physiographic type: 'Large shallow inlets and bays'

A section of Nigg Bay is designated as a SSSI for its geological importance for its quaternary stratigraphy associated with glacial deposition (as presented in Chapter 6: Marine Physical Environment and Chapter 10: Nature Conservation).

The site boundary for the proposed development encompasses Balnagask to Cove, which is designated as a LNCS. This is a non-statutory local designation, identified by local authorities as per the Scottish Government's Planning Policy. Protection is afforded through the Council's Local Development Plan. These sites are of local importance for nature conservation (Aberdeen City Council, 2015). The local importance of this site is associated with coastal cliffs and caves, shingle beaches, coastal and neutral grassland, European dry heath and coastal heath, as well as areas of gorse scrub, which host interesting coastal plants and associated insects.

The EIA Scoping Report (ES Appendix 1-E) noted the potential presence of the oyster plant (*Mertensia maritima*) within Nigg Bay. This is a terrestrial plant associated with the terrestrial BAP habitat, coastal vegetated shingle. As such it has been considered within Chapter 11: Terrestrial Ecology. However, Alexander et al (1998) note that coastal strandline communities on shingle beaches can be important for this nationally scarce oyster plant. In this context it is worth noting from the technical survey report (ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey) that there was 'a relatively light strandline composed mainly of cast fucoids, with many kelp flies and a few talitrids'. The report went on to note that this was clearly 'highly variable' and in fact had 'moved up the shore a few tens of metres to the north on the second day of survey'. Therefore, although the biotope **LS.LSa.St.Tal** Talitrids on the upper shore and strand-line was recorded, its transitory, ephemeral nature should be noted.

12.6.2.2 Subtidal Survey

CMACS Limited carried out a baseline survey of the subtidal area of Nigg Bay and adjacent areas from 14 March to 22 March 2015 inclusive (ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey).

Methodology

The survey methods and locations were developed in collaboration with MS prior to survey. The overall survey plan, which was created with the aid of existing detailed swathe bathymetry and sidescan sonar survey images (to ensure sampling of a variety of seabed types), involved the use of:

- Drop down video plus grab sampling for sediment and macrofaunal analysis at 30 stations was attempted;
- Additional sediment sampling at 10 of the stations for analysis of possible chemical contaminants; and
- 2 m scientific beam trawl survey at 5 locations, primarily for additional information on benthic epifauna to supplement macrofaunal analysis.

Dispensation was received from MS-LOT for the use of the 2 m scientific beam trawl and appropriate Notices to Mariners were issued.

Camera survey was carried out before grab sampling to collect information on seabed habitats and epibenthos and also to prevent grab sampling from taking place on unsuitable substrates such as large boulders, where damage to the grab might be likely, or in sensitive habitats such as Annex I features where damage to the feature might have occurred.

Results

Drop down video was undertaken at all of the proposed 30 stations (Figure 12.3). Grab samples for macrofauna and sediment particle size analysis were successfully obtained from 25 of the 30 proposed stations (Figure 12.3). Contaminant samples were successfully taken at all 10 proposed stations and trawls at all 5 proposed locations (Figure 12.3).

Particle Size Analysis

Results from the Subtidal Benthic Ecological Characterisation Survey (ES Appendix 12-A) particle size analysis are illustrated in Figure 12.4. Sand was the dominant fraction in 90% of the samples, with more than 70% of samples comprised of more than 97% sand. The dominant sand fraction was fine sand though medium sands, which were largely offshore sampling station. Gravel and mud content were low, with slightly muddier stations found close inshore within Nigg Bay and to the north of the existing Aberdeen Harbour. With the exception of Station 27, all sediments were moderately well, well or very well sorted.

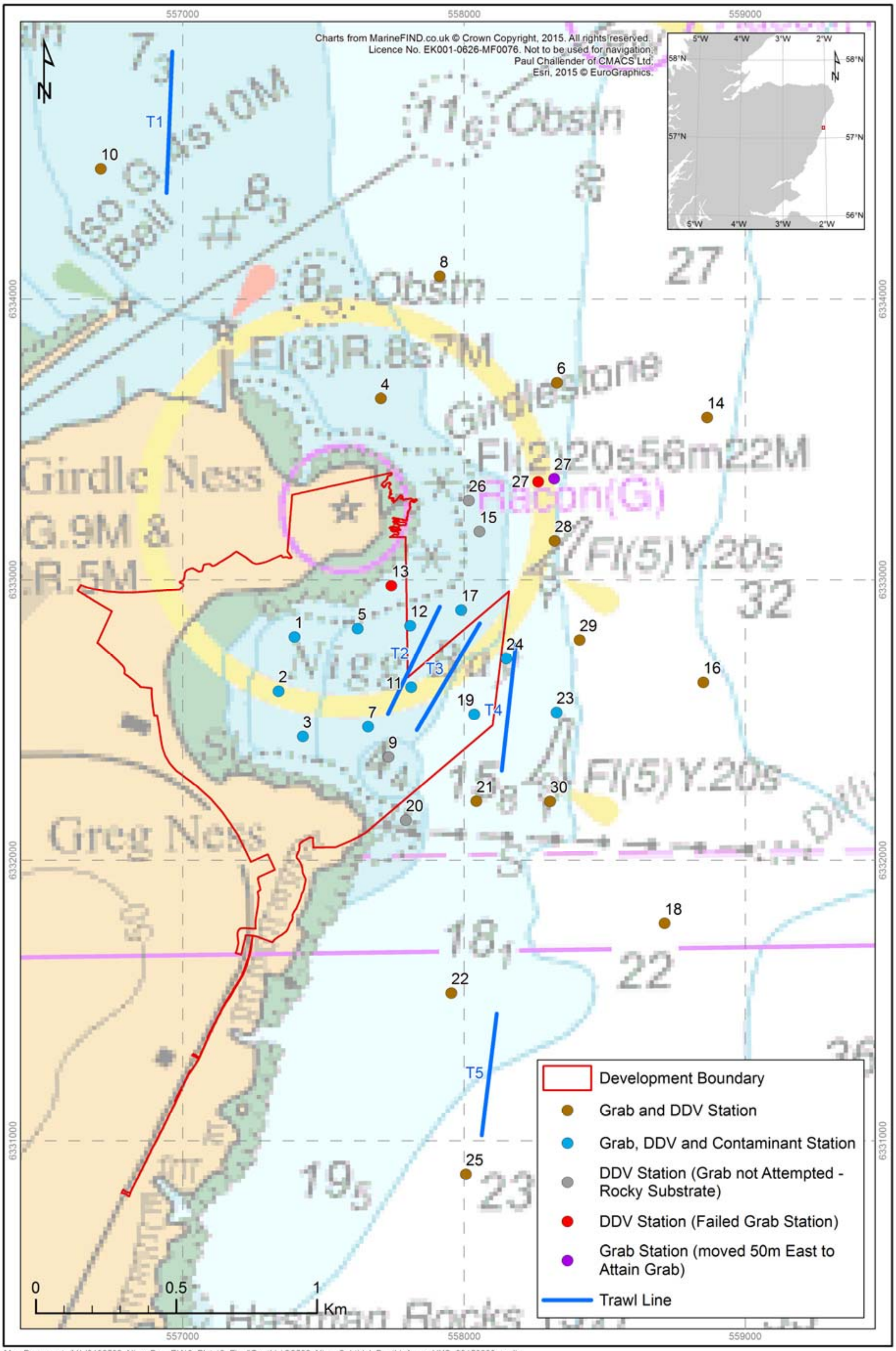

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Figure 12.3: Subtidal benthic array including grabs, trawls and video locations, Nigg Bay survey, March 2015

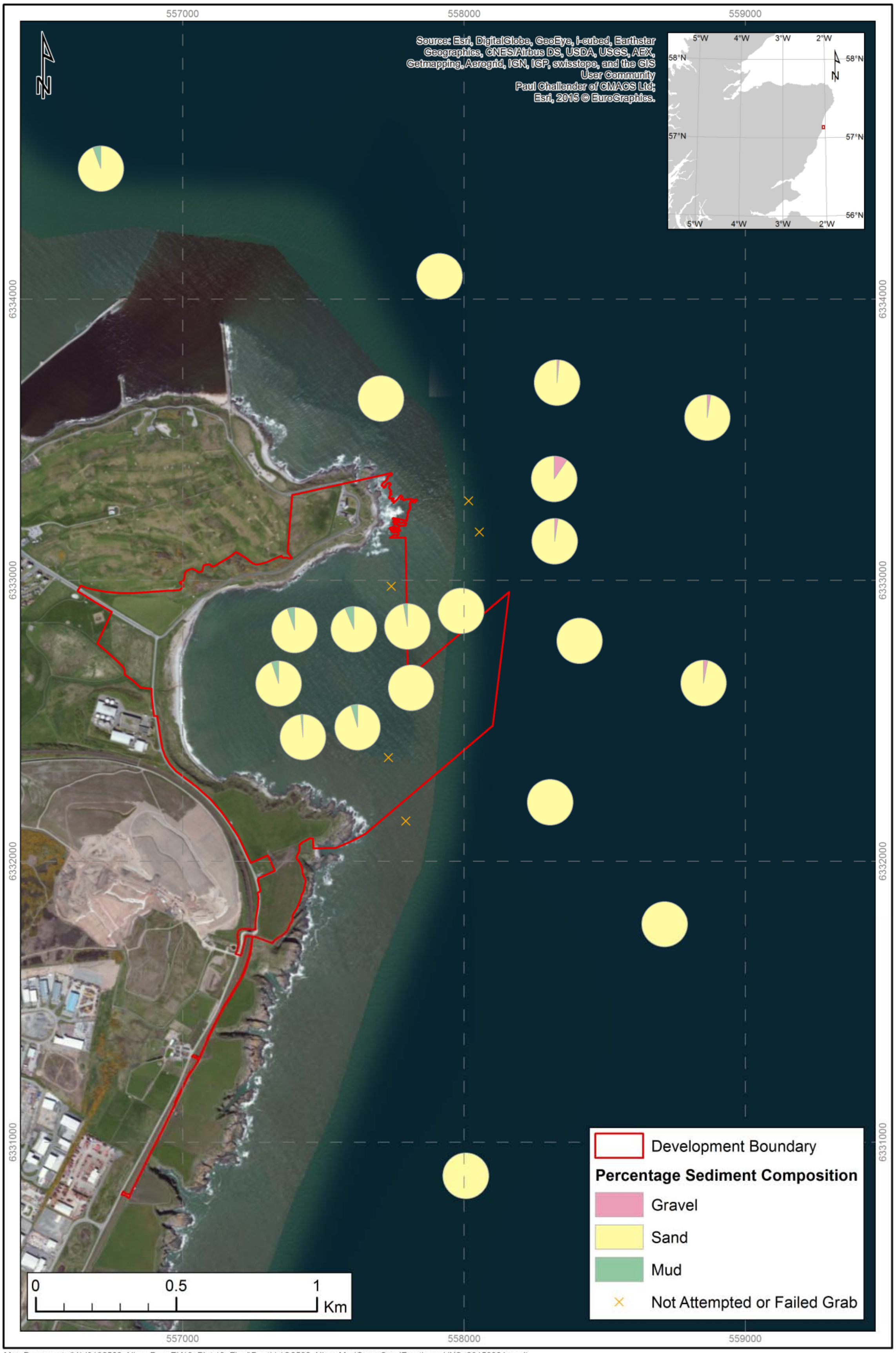

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Figure 12.4: Subtidal benthic survey particle size analysis, Nigg Bay survey, March 2015

Sedimentary Biotopes

The widespread biotope **SS.SSa.IFiSa.NcirBat** *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand, which is typical of more mobile inshore sands, was largely poor in both species and numbers of individuals (and biomass was also low throughout). This biotope was dominated by the catworm *N. cirrosa*, and other polychaete worms. Smaller patches of other sedimentary biotopes were present in a few places; these were again species poor, with a low biomass, and largely dominated by worms.

Three stations were identified as the biotope **SS.SCS.ICS.Glap** *Glycera lapidum* in impoverished infralittoral mobile gravel and sand with a fourth station, in a similar location, left at the higher, biotope complex level (**ICS**). The bivalve *T. fabula* (previously known as *Fabulina fabula*) was moderately abundant in parts of the **NcirBat** biotope, in particular close inshore in Nigg bay. Station 12, at the entrance to Nigg Bay, best matched the muddy sand biotope **SS.SSa.IMuSa.FfabMag** *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand, although it was noted as a poor expression of the habitat.

Rock Biotopes

Hard substrates were mostly found off Girdle Ness to the north, and extending in a narrow band into Nigg Bay, and in smaller areas off Greg Ness to the south. These appeared to be largely composed of boulders, though areas of bedrock also occurred off Girdle Ness. The rocky sublittoral biotopes associated with these areas of Nigg Bay were largely sparse examples of the **Cr.MCR.EcCr** Echinoderms and crustose communities biotope complex. However, within this area there were also patches of sand, and where these were most extensive the areas have been mapped as a mosaic of the **EcCr** biotope with sediment biotopes (**Glap** or **NcirBat**). The **EcCr**/**Glap** mosaic was identified off Girdle Ness whilst the **EcCr**/**NcirBat** mosaic off Greg Ness. It was thought that the **EcCr** biotope probably changes rather gradually into the lower shore *L. digitata* (**Ldig**) biotope as depths become shallower, although no evidence of algal dominated biotopes was seen in any of the camera images.

The **EcCr** biotope on the boulders and rock comprised a sparse and species poor turf fauna dominated by small amounts of dead man's fingers *Alcyonium digitatum*, occasional hydroids and bryozoans forming a sparse, short turf, and with considerable numbers of common starfish *Asterias rubens* throughout. Large numbers of empty barnacle tests were seen in many places, with very few live individuals noted. Other fauna seen in small amounts included unidentified small patches of encrusting material that may have been colonial ascidian or sponge, small crusts of yellow sponge, occasional solitary hydroid polyps (possibly *Tubularia* sp or *Sarsia* sp) 2 plumose anemones *Metridium senile*, 2 individuals of the anemone *Sagartia* sp, and occasional small prawns. The lack of fauna appears likely to be heavily influenced by the large amounts of mobile sand, and it is suspected that the amount and depth of sand might be variable from year to year. Using the characterising features presented by Irving (2009) for stony reef the main areas of rocky substrata were suggested as being of medium 'reefiness', whilst those parts where there was a higher proportion of sand were considered more likely to be of low to medium 'reefiness'. No areas surveyed suggested a high score for 'reefiness'.

Trawl Survey

The 5 trawl survey transects caught 664 individual fish from 10 taxa and 1,123 invertebrates (excluding colonials) from 5 epifaunal taxa (eight if colonial taxa are included). The fish are considered within Chapter 13: Fish and Shellfish Ecology. Invertebrate abundance was completely dominated by the brown shrimp *C. crangon* which accounted for approximately 95% of the total number of individuals caught. Of the total number of brown shrimp caught (1,066) Trawl T2 and T3 nearest to Nigg Bay accounted for 85% with T2 alone capturing more than 50% of the numbers of individuals (557). The next most abundant species with 42 individuals caught was the flying crab *L. holsatus* with more than 80% of the total number split roughly equally between T1 in the entrance to the existing Aberdeen Harbour and T2 in the mouth of Nigg Bay. These results are similar to those obtained from survey work in Aberdeen Harbour associated with the EOWDC.

Contaminant Analysis

The levels of all potential contaminants analysed (a range of metals, Tributyl Tin (TBT); Polychlorinated Biphenyls (PCBs) and Polycyclic Aromatic Hydrocarbons (PAHs)) were found to be consistently well below the Marine Scotland Action 1 levels at all stations, see ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey.

Subtidal Biotopes of Ecological and Conservation Interest

The biotope map generated from the subtidal survey work is provided (Figure 12.5).

None of the biotopes recorded from the subtidal survey are component parts of any of the currently identified Scottish PMFs. Similarly, none of the benthic invertebrate species recorded are identified as PMFs. Three mobile fish species that are considered as PMFs were encountered; these were whiting and sand gobies in the trawls, and sandeels which were frequently encountered throughout (in grabs, camera images, and beam trawls, as well as during the intertidal surveys of 2014 (ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey), along with a number of commercial fish species, notably plaice, that were also seen in the trawls. These species are considered in Chapter 13: Fish and Shellfish Ecology.

Based on the JNCC (2014) marine habitat correlation table the sediment biotopes recorded may occur in the Annex I habitat, ‘Sandbanks which are slightly covered by sea water all the time’ and the rock biotopes may occur in ‘reefs’ (Table 12.7).

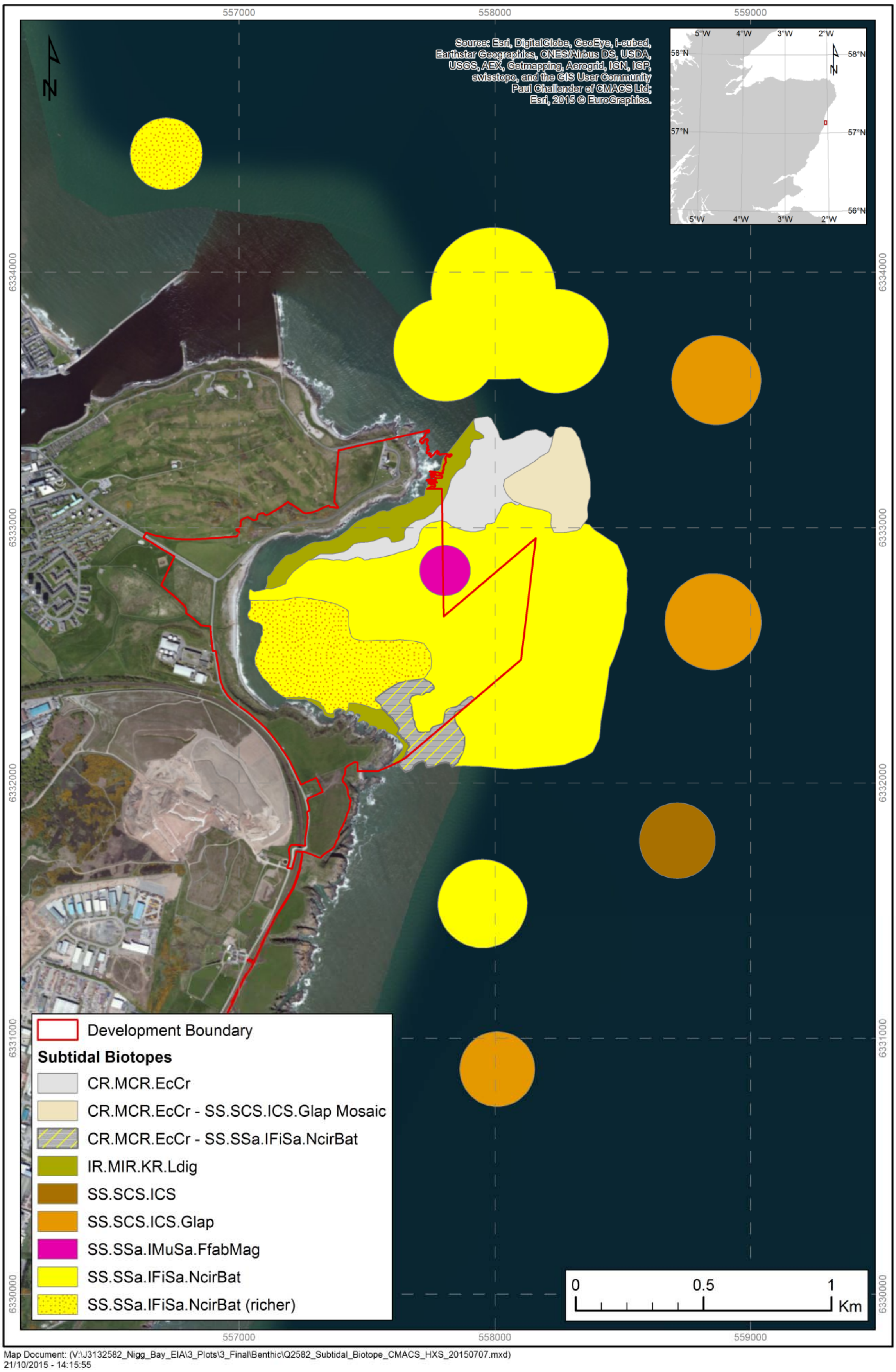

Figure 12.5: Distribution of subtidal benthic biotopes

Table 12.7: Correlation between recorded subtidal biotopes and Annex I features

Code	Description	Relation to Annex I 'Habitat' Types	Annex I
SS.SSa.IFiSa.NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	< May occur	Sandbanks which are slightly covered by sea water all the time
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	< May occur	Sandbanks which are slightly covered by sea water all the time
SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand	< May occur	Sandbanks which are slightly covered by sea water all the time
SS.SCS.ICS	Infralittoral coarse sediments	< May occur	Sandbanks which are slightly covered by sea water all the time
Cr.MCR.EcCr	Echinoderms and crustose communities	<	Reefs
IR.MIR.KR.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock	<	Reefs

No designated SAC or Area of Search for possible future SACs with respect to either sandbanks which are slightly covered by sea water all the time, or reef features, exists in the region of Nigg Bay. The Subtidal Benthic Ecological Characterisation Survey (ES Appendix 12-B) noted that some areas of rock and boulders showed medium 'reefiness' when assessed using the Irving (2009) criteria for stony reef (ES Appendix 12-B). Although not a high score this suggests, to a degree, Annex I geogenic reef habitat. However, the report also noted that 'the associated community is very sparse and species poor, being dominated by common starfish *Asterias rubens* and small amounts of dead man's fingers *Alcyonium digitatum*, both of which can be expected to be very widespread and abundant in Scottish waters'.

The ross worm *Sabellaria spinulosa* was present in small numbers in the grab samples from 2 stations (Stations 16 and 27) and evidence of some loose, small, empty/broken tubes were observed in three static images from the camera survey (Station 16). However, there was no indication of any biogenic reef-like *S. spinulosa* aggregations.

None of the invertebrate species encountered are listed on the Scottish Biodiversity list (2013). One habitat of principal importance of relevance was 'Subtidal sands and gravels' (UK BAP, 2008b; JNCC, 2015b). The biotopes associated with this habitat include **SS.SCS.ICS** Infralittoral coarse sediment; **SS.SSa.IFiSa** Infralittoral fine sand; and, **SS.SSa.IMuSa** Infralittoral muddy sand. These biotope complexes were found in the survey area with the biotope **SS.SSa.IFiSa.NcirBat** dominant.

A Water Framework Directive (WFD) biological assessment was carried out on the macrofaunal grab data. All stations had an ecological status class within the Ecological Quality Ratio (EQR) of either 'Moderate' (13 stations) or 'Good' (11 stations), except for Station 18 which was 'High'. The 5 stations within the bay (1, 2, 3, 5 and 7) were classified as being of 'Moderate' status. This was followed by a band of 'Good' and then 'Moderate' status before returning to 'Good'/'High' in the offshore area/more distance sites. Further information on the WFD biological assessment is described in ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey.

12.7 Assessment of Effects

12.7.1 Project Description

Table 12.8 presents the project metrics used to assess each of the predicted effects of the construction and operation of the project, and are taken from the project description provided in ES Chapter 3: Description of The Development.

Table 12.8: Project metrics used in the assessment of impacts on benthic ecology

<table>
<tr><th>Description of Impacts</th><th>Project Metrics Considered in the Assessment of the Effect</th></tr>
<tr><td colspan="2">Construction</td></tr>
<tr><td>Reduction in the extent of original seabed habitat.</td><td>As a result of the placement of the proposed harbour infrastructure within Nigg Bay there will be a permanent loss of 71,133.15 m^2 of intertidal habitat which equates to 32% of the total intertidal area within the development boundary. Similarly, the development footprint in the subtidal area indicates that 140,984.76 m^2 of original seabed habitat will be lost and this equates to 25% of the total subtidal area within the EIA boundary. Furthermore, seabed depths within the site will be increased to 9.0 m below Chart Datum within the inner basin and 10.5 m below Chart Datum in the approach channel and along the East Quay.</td></tr>
<tr><td>Temporary seabed disturbances disrupting habitats and associated species.</td><td rowspan="4">The seabed will be deepened within the inner basin area, at East Quay and along the approach channel using a trailer suction hopper and/or backhoe dredging method. Dredging activity is anticipated to take up to 19 months and dredging could take place seven days a week and 24 hours a day throughout the year with up to 3 barges operating at any one time.

The rock generated from the dredging and blasting operations will be beneficially used within the construction, where possible. The remainder of the dredged material will be transported away from site by bottom opening barge and disposed at an existing licenced marine disposal site.</td></tr>
<tr><td>Temporary increases in suspended sediment concentrations (SSCs), reducing light, clogging gills and feeding apparatus etc. with deposit feeding communities less affected than suspension feeders.</td></tr>
<tr><td>Temporary increases in sediment deposition leading to smothering/burial and associated costs (e.g. mortality, energetic costs of repositioning).</td></tr>
<tr><td>Temporary release of sediment contaminants and associated water quality changes with increase in bio-availability and potential impairments to individuals/populations.</td></tr>
<tr><td>Increased levels of underwater noise/vibration due to piling, drilling and blasting (potential mortality and avoidance behaviour and susceptibility of sessile fauna).</td><td>Blasting of the seabed will be undertaken using explosive in areas of rock to facilitate the dredging process. Drilling will be used to place the explosives within the rock.
Piling will be undertaken to install sheet pile walls as part of the construction of the quays.</td></tr>
<tr><td>Accidental releases of environmentally harmful substances with specific effect(s) dependent on material(s) involved.</td><td>The construction window is 3 years.</td></tr>
<tr><td>Offshore disposal of dredged material.</td><td>The total volume of material to be dredged is 2,300,000 m^3 with up to 45% being potentially re-usable. Any material not reused will be disposed of at the licensed disposal site offshore of Aberdeen.</td></tr>
</table>

Table 12.8: Project metrics used in the assessment of impacts on benthic ecology continued

<table>
<tr><th>Description of Impacts</th><th>Project Metrics Considered in the Assessment of the Effect</th></tr>
<tr><td colspan="2">Operation and Maintenance</td></tr>
<tr><td>Introduction of new seabed habitat. Change in biodiversity and exploitation of artificial habitat by marine non-native species.</td><td>The proposed harbour infrastructure, including the vertical surfaces of breakwaters and quaysides, together with any scour protection material on the seabed, will provide a new hard substrate resulting in a change to biodiversity and exploitation of artificial habitat by non-native species.
The capital dredging will deepen the seabed within the harbour creating a deeper water habitat compared to the baseline.</td></tr>
<tr><td>Changes to hydrodynamic regime.</td><td>Localised increases in current speeds around breakwaters and greater retention times of water within the Bay.</td></tr>
<tr><td>Temporary seabed disturbances and increases in SSCs due to prop wash.</td><td>The traffic predicted to use the development on an annual basis is approximately 550 commercial vessels; 1,700 PSV/Offshore vessels; 40 DSV and 33 cruise ships; in addition to the vessel traffic currently using the existing harbour. The wash from operational propellers of vessels using the harbour may disturb seabed sediments and temporarily raise sediment plumes.</td></tr>
<tr><td>Temporary seabed disturbances and increases in SSCs due to channel maintenance dredging.</td><td rowspan="3">The entrance channel is expected to be required to be annually. Dredged material will be transported away from site and disposed at an existing licensed marine disposal site.</td></tr>
<tr><td>Temporary increases in sediment deposition due to maintenance dredging.</td></tr>
<tr><td>Temporary release of sediment contaminants due to maintenance dredging.</td></tr>
<tr><td>Increased levels of underwater noise from increased vessel traffic.</td><td>Exposure to noise generated from the vessels which will subsequently utilise the proposed harbour facilities.</td></tr>
<tr><td>Offshore disposal of dredged material.</td><td>Maintenance dredged material will be disposed of at the Aberdeen offshore disposal site.</td></tr>
</table>

The change in baseline conditions within the harbour and the approach channel means that assessing temporary effects of the development in this area is redundant. Habitats and the associated species currently present will either be lost beneath the footprint of the infrastructure being put in place or completely removed by the necessity of dredging to a depth of 9 m below Chart Datum in the inner basin and 10.5 m below Chart Datum along the East Quay and the approach channel. These impacts will be assessed under the operational phase as a reduction in the extent of original seabed habitat.

12.7.2 Design Parameters Used in the Assessment

The procurement process and appointment of contractors for the D&B contract had not concluded at the time of production of this ES. The final method of construction may deviate from that described in this chapter, but any deviation will be within the parameters of the development's realistic worst case scenario (known as the 'Rochdale Envelope'), which has been further detailed in ES Chapter 5: Environmental Impact Assessment Process.

By adopting the Rochdale Envelope approach, it is possible to assess the effects of the realistic worst case scenario for the development in this ES. All mitigation recommendations within this ES are based upon these realistic worst case scenarios.

12.7.3 Construction Phase

12.7.3.1 Permanent Loss of Seabed Habitat

The construction activities including the quayside and breakwater construction and capital dredging across most of the project area will result in the complete loss or severe modification to most, if not all, of the intertidal and subtidal marine habitats present within the project footprint. This section will assess the significance of the loss of these benthic habitats within the project area.

As a result of the placement of the proposed harbour infrastructure within Nigg Bay there will be a permanent loss of 71,133.15 m^2 of intertidal habitat, which equates to 32% of the total intertidal area within the development boundary. Similarly, the development footprint in the subtidal area indicates that 140,984.76 m^2 of original seabed habitat will be lost and this equates to 25% of the total subtidal area within the EIA boundary.

The greatest loss of habitat comes from the necessity of creating seabed depths within the site of 9.0 m below Chart Datum within the inner basin and 10.5 m below Chart Datum in the approach channel and along the East Quay. The original sedimentary environment is sand dominated but the dredging activity will remove the surficial sand deposits in the bay entirely exposing the underlying coarser fluvio-glacial deposits and, in places, bedrock. No return to sand dominated habitats is predicted. The deepening will also excavate the intertidal area removing both soft sediment and rock biotopes. Should any rock remain the exposure conditions will be different to those which previously helped to create the habitat, therefore all original seabed habitat (both intertidal and subtidal) within the footprint of the proposed development and the dredged area is considered lost in this assessment.

In a regional/national context the loss of habitat previously present within Nigg Bay is considered unlikely to result in impairment to ecosystem functioning at these scales. As Figure 12.1 clearly indicates, similar subtidal sedimentary habitat is present to both the south and, more extensively, to the north. The dominant sediment biotopes are illustrative of the UK BAP habitat ‘subtidal sands and gravels’ and, although of high value, the JNCC (2012) notes that these are ‘*the most common habitats found below the level of the lowest low tide around the coast of the United Kingdom*’. As the marine habitat classification indicates (Connor *et al*., 2004), the rocky habitats encountered are not unique or unusual in a national context and in fact the coast, in particular to the south, has other examples of pocket or bayhead type beaches bounded by headlands. Furthermore, the intertidal substrate foreshore available at magic.gov.uk indicates that rock habitat forms a continuum to the south, strongly suggesting the potential occurrence of similar biotopes.

Any potential effects on associated receptors including fish, birds and marine mammals have been assessed in the relevant chapters of this ES (ES Chapter 13: Fish and Shellfish Ecology, ES Chapter 14: Marine Ornithology and ES Chapter 15: Marine Mammals). The project footprint, and overlap with the subtidal biotopes is illustrated in Figure 12.6. An overview of the assessment is provided in Table 12.9.

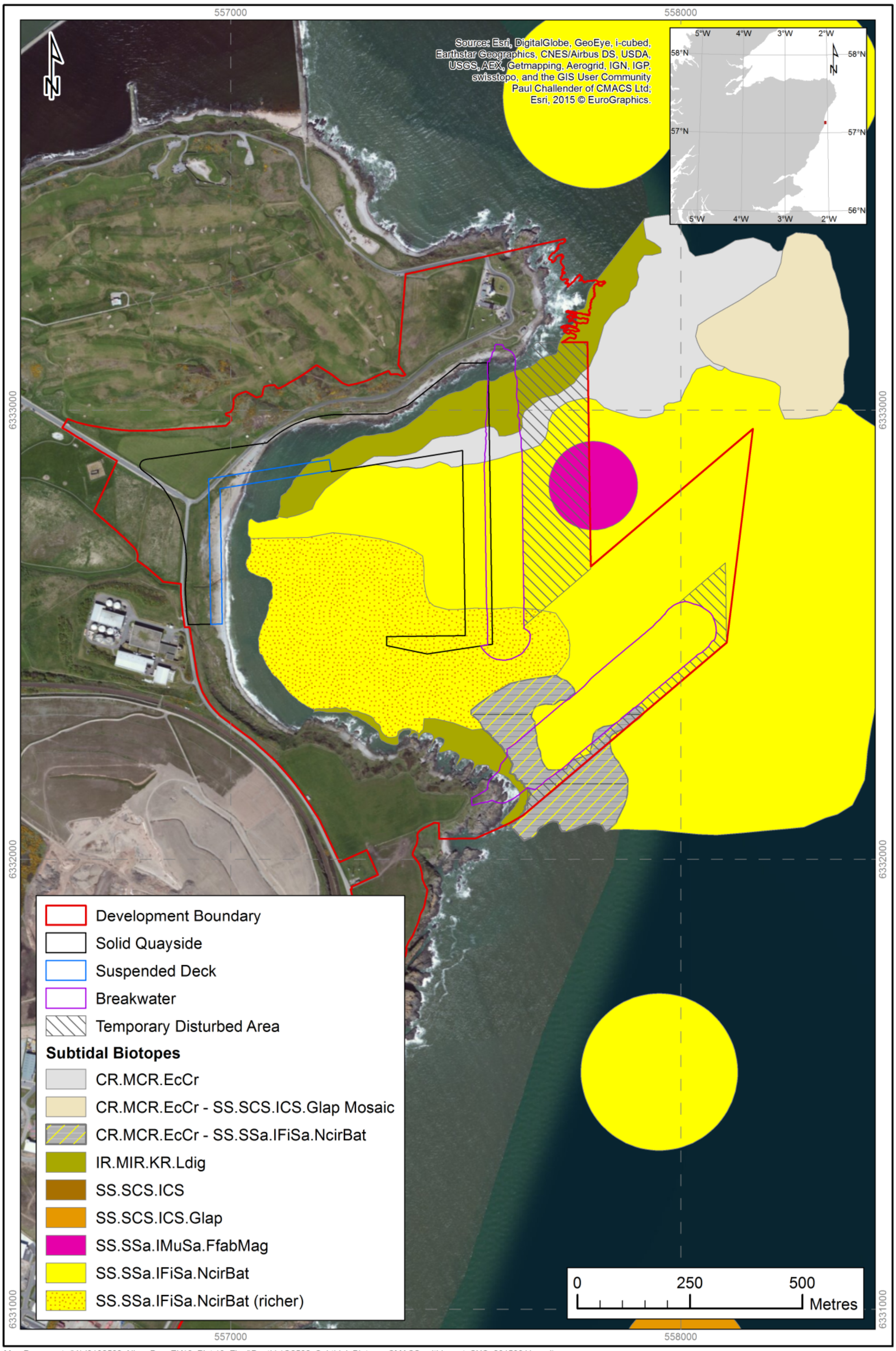

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Figure 12.6: Overview of project footprint and existing subtidal biotopes

Table 12.9: Assessment of effects on benthic ecology with respect to permanent loss of seabed habitat

Receptor/Biotope	Description	Magnitude of Effect	Value	Overall Significance of Effect	Conservation Significance
SS.SSa.IFiSa.NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	Major	High	Major adverse	UK BAP Habitat 'subtidal sands and gravels'
Cr.MCR.EcCr	Echinoderms and crustose communities	Major	Negligible	Minor adverse	None
IR.MIR.KR.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock	Major	Negligible	Minor adverse	None
LR.HLR.MusB.Sem.Sem	*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.LLR.F.Fves.FS^	*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock	Major	Negligible	Minor adverse	None
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	Major	Negligible	Minor adverse	None
LR.FLR.Eph.EphX	Ephemeral green and red sea weeds on variable salinity and/or disturbed eulittoral mixed substrata	Major	Low	Moderate adverse	LNCS Balnagask to Cove
IR.MIR.KR.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove

Table 12.9: Assessment of effects on benthic ecology with respect to permanent loss of seabed habitat continued

Receptor/Biotope	Description	Magnitude of Effect	Value	Overall Significance of Effect	Conservation Significance
LS.LSa.MoSa	Barren or amphipod dominated mobile sands	Major	Negligible	Minor adverse	None
LS.LCS.Sh.BarSh	Barren littoral shingle	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LS.LSa.St.Tal	Talitrids on the upper shore and strandline	Major	Negligible	Minor adverse	None
LR.LLR.F.Pel^	*Pelvetia canaliculata* on sheltered littoral fringe rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.FLR.Eph.EntPor	*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock	Major	Negligible	Minor adverse	None
LR.FLR.Lic.YG	Yellow and grey lichens on supralittoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.HLR.FR.Mas	*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.HLR.MusB.Sem.LitX	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles	Major	Low	Moderate adverse	LNCS Balnagask to Cove

Table 12.9: Assessment of effects on benthic ecology with respect to permanent loss of seabed habitat continued

Receptor/Biotope	Description	Magnitude of Effect	Value	Overall Significance of Effect	Conservation Significance
LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on exposed littoral fringe littoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.FLR.Lic.Ver.B	*Verrucaria maura* and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock	Major	Low	Moderate adverse	LNCS Balnagask to Cove
LR.FLR.Rkp.Cor	Coralline crust-dominated shallow eulittoral rockpools	Major	Low	Moderate adverse	LNCS Balnagask to Cove

Following construction of the harbour, it is anticipated that there will be regular maintenance dredging activities during the operational phase of the project. The impacts associated with the operation of the harbour are discussed in Section 12.7.4.

Impact on Features of Conservation Interest

<u>Annex I Habitats</u>

There are no designated marine conservation areas within Nigg Bay. There is a SSSI but this is for geological, not biological, interest. Some of the biotopes identified from the intertidal and subtidal surveys are indicative of Annex I 'Mudflats and sandflats not covered by seawater at low tide', 'Sandbanks which are slightly covered by seawater all of the time' and 'Reef' habitats although there are no types of these designated habitats present within Nigg Bay.

The subtidal rock habitats, comprised of the two biotopes **EcCr** and **Ldig**, were assessed for their 'reefiness' based on the definitions provided by Irving (2009) and were found to have a low to medium resemblance to Annex I 'Reef' across the survey area. However, the associated communities were assessed as very sparse and species poor, and were dominated by common starfish *Asteria rubens* and small amounts of dead man's fingers *Alcyonium digitatum*, both of which are considered widespread and abundant in Scottish waters. As for Annex I 'Sandbanks', there are no identified Annex I 'Reef' habitats in the vicinity of Nigg Bay, therefore no assessment of potential impact or effect on such a feature is necessary.

Overall Assessment

Tolerance and recoverability to a loss of habitat are negligible for all biotopes so sensitivity is high and the spatial extent is large within the immediate development area, although within the context of the wider availability of these habitats across the region the spatial extent will be negligible. Impact duration is permanent for the lifetime of the harbour. The magnitude for all biotope receptors is therefore assessed as negligible. None of the biotopes are valued as Annex I habitats but the dominant sublittoral sediment biotope NcirBat, is associated with the habitat of principal importance ‘subtidal sands and gravels’ and as such, its value is assessed as **high**. The significance of the effect for this receptor, covering the majority of the subtidal area within Nigg Bay, is therefore assessed as **minor adverse**, which is not significant in EIA terms.

The remaining sublittoral biotopes which will be lost are EcCr and Ldig. Neither of these are captured by any conservation designation and therefore their value is assessed as negligible. The significance of the effect for these two biotopes is therefore assessed as **minor adverse,** which is not significant in EIA terms

None of the intertidal biotopes identified are valued as either Annex I habitats or habitats of principal importance but parts of the intertidal area are included within the LNCS Balnagask to Cove. Twelve of the biotopes fall within this local designation (Table 12.9) and as such value for these is assessed as low. The significance of the effect for these habitats is therefore assessed as **moderate adverse**. For the remaining five biotopes value is assessed as negligible and the significance of the effect is therefore, **minor adverse**, which is not significant in EIA terms.

The uncertainty associated with this assessment is low as receptor responses are well studied, the interactions well understood, and there is no question that the habitats and species will be lost and that there will be no recovery within the lifetime of the project.

12.7.3.2 <u>Temporary Physical Seabed Disturbance</u>

Temporary physical seabed disturbance (outside of areas that will be permanently disturbed within the harbour) will be restricted to two areas within the project boundary (Figure 12.6). The largest of these areas lies to east of the proposed north breakwater which may be used as a temporary lay down area during construction as detailed in ES Chapter 3: Description of the Development. The other area is located to the south and east of the proposed south breakwater and will be temporarily impacted by spud legs by the jack up/crane barges during construction. The combined area of temporary disturbance will be 0.11 km^2. The biotopes present in these areas are **NcirBat**, **FfabMag**, **EcCr** and **Ldig**.

The **NcirBat** biotope is characteristic of dynamic sand habitats subject to frequent disturbance by wave action or tidal currents. The species assemblages associated with these communities are therefore adapted to recurrent erosion and accretion (Connor et al., 2004). The more opportunistic nature of the species populating **NcirBat** biotopes means they can recover quickly from even significant disturbance events, aided by the local planktonic larval pool and migration from nearby areas provided suitable habitat remains. Budd (2006) in the MarLIN sensitivity assessment for the biotope with regard to abrasion and physical disturbance recorded a ‘very low’ sensitivity for the biotope. Within the context of this EIA there is high recoverability and high tolerance to the effects of physical disturbance coupled with a restricted spatial extent and temporary duration. Furthermore the biotope will have a wide regional presence untouched by the proposed development, suggesting broader ecosystem function will be unaffected. Magnitude is therefore assessed as negligible. In terms of value it is considered of high value as shown in Table 12.9. The significance of the effect is therefore assessed as **negligible,** which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

FfabMag has a low sensitivity to physical disturbance (Rayment, 2006). Recovery would be expected within 5 years based on a high recoverability but intermediate tolerance. However, the spatial extent of the impact is limited and the duration is temporary. In addition, the extent of the mapped biotope is small and, as clearly suggested by both Figure 12.1 and the baseline information (Section 12.6.1.2), it is likely to have a wider presence regionally that will remain untouched by the proposed development, suggesting broader ecosystem function will be unaffected. The magnitude is therefore assessed as negligible. As shown in Table 12.9, this biotope is regarded as of high value. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

There is no sensitivity assessment for **IR.MIR.KR.Ldig** on the MarLIN website, however, there is one for the related biotope **IR.MIR.KR.Ldig.Ldig**. **Ldig.Ldig**, which has a low sensitivity to abrasion and physical disturbance as although tolerance is intermediate, recoverability is high (Hill, 2000). **Ldig** encountered in the survey area was both sand scoured and unstable in places and will therefore have an equally low sensitivity to disturbance in the worst case. The impact will have a highly restricted spatial extent and very limited temporary duration. Furthermore, as indicated in Section 12.7.3.1, the biotope will likely have a wide regional presence untouched by the proposed development indicating any broader ecosystem function will be unaffected. Magnitude is therefore assessed as negligible. As shown Table 12.9, this biotope is regarded as of negligible value. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

CR.MCR.EcCr does not have a sensitivity assessment on the MarLIN website but other biotopes such as **CR.MCR.EcCr.FaAlCr.Pom** within the complex do and are considered to have 'low' sensitivity to abrasion and physical disturbance (Tyler-Walters 2002a). **EcCr** is assessed here as having a similarly 'low' sensitivity. As with **Ldig** magnitude and value are assessed as negligible. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

WFD Ecological Quality Status

The WFD assessment undertaken on the macrobenthic samples within Nigg Bay were assessed as having a "Moderate" ecological quality (Section 12.6.2.2) which is reflective of moderate disturbance. The construction of the harbour and subsequent maintenance dredging can be considered a severe seabed disturbance which would potentially reduce the macrobenthic ecological quality in the immediate area to a "bad" status (EQR <0.24). The ecological quality for 10 out of 11 stations outside Nigg Bay were assessed as being of "Good" status (slightly disturbed) and one was of "High" status (no or very minor disturbance). Although it is not known what factors might be influencing the WFD descriptions, it can be expected that the ecological quality status of these sites may also be temporarily reduced to that of a moderately disturbed community, particularly in areas within or adjacent to the temporarily disturbed areas highlighted in Figure 12.6. However, as discussed above it is expected that there will be a recovery of the benthos in the areas out with the immediate footprint of the proposed harbour development and therefore a return to “Good” status is expected in the longer term. Although a WFD assessment of the ecological status of the intertidal receptors was not assessed, the construction of the harbour will effectively remove much of the existing intertidal habitat. Given that the benthic environment within the proposed harbour area will be severely disturbed with little opportunity to recover, this area will resemble that of a Heavily Modified Water Body. Further information on water quality can be found in ES Appendix 7-B: Water Quality Modelling Assessment.

12.7.3.3 Temporary Increases in Suspended Sediment Concentrations (SSCs) due to Dredging

Dredging of the seabed and seabed preparatory works will disturb the seabed resulting in the mobilisation of sediment into the water column increasing suspended sediment concentrations (SSCs). As Tillin et al. (2011) note, sediment released into the water column will be dispersed laterally and vertically by waves, tides and gravitational settling. The spatial extent of this plume is largely determined by the resource composition and the local hydrodynamic regime, with heavier gravel-sized particles settling rapidly at the discharge point, whilst sand-sized particles generally settle within approximately 250 m to 500 m (and within 5 km where tidal currents are strong) (Hitchcock and Drucker, 1996, Newell et al., 2004a). Where screening is not used, as would be the case here, the volume of discharged sand is much smaller and effects may be confined to the dredge area (Newell et al., 2004a). Some overflow from the trailer suction hopper dredger used during the dredging work is anticipated. The dispersion of the sediment plume may therefore have an effect on the benthic receptors outside of the dredging areas.

ES Appendix 6-A: Oceanographic Works, provides the results of the SSC monitoring and describes the typical (mean) levels of SSCs in Nigg Bay as 144 mg/l (west location sampling point), whilst just outside of Nigg Bay (east location sampling point) the mean value is 24 mg/l. Maximum values recorded at these locations were considerably larger being 899 mg/l (west) and 529 mg/l (east), with good correspondence between wave height and high SSC values. This is expected as high energy sea states will re-suspend fine seabed sediments in particular. However, sometimes high SSCs were measured during calm sea states suggesting additional influences such as fresh water run-off or outfall discharge.

ES Appendix 7-D: Sediment Plume Modelling provides the results of numerical modelling predicting the spatial and temporal extents of increases in SSCs arising from the construction and operation phases of the proposed scheme. Greatest SSCs will be created during the trailer suction hopper dredging of the unconsolidated sediments. The plume modelling work shows that sediment released within Nigg Bay as a result of spill during the construction phase is largely predicted to remain within the development area, with the exception of mud (ES Appendix 7D: Sediment Plume Modelling). The report attributes this to low current speeds created by the partially constructed breakwaters (ES Appendix 7-D: Sediment Plume Modelling). Mud particles will remain in suspension for longer and will therefore be transported outside of the bay via tidal currents. Dispersion will be mostly to the north towards the entrance of the River Dee following the dominant current movement.

Peak SSCs during TSHD overspill are predicted to >8,000 mg/l at the immediate dredging location. Coarse sediments are predicted to settle quickly, limiting the spatial extent of plumes, and SSC levels for coarse sediments are predicted to be indistinguishable from natural levels around some of the periphery of the Bay. Finer sediments will travel further, however peak SSCs during TSHD are not predicted to be greater than 100 mg/l to 200 mg/l north of Girdle Ness and generally around 10 mg/l to 40 mg/l in front of the mouth of the River Dee, which is well within natural background variation. For this fraction, the peak values are very short-lived, returning to background levels before the next overspill episode. In general, it is therefore predicted that the effects of the dredging will be largely limited to the construction area only. The impact will be intermittent but continuous and temporary, lasting only for the duration of the capital dredge (19 months).

During backhoe dredging of the layer of consolidated material, overspill of the buckets will release part of the sediment dredged into the water column, resulting in increased SSCs within Nigg Bay. The model shows that all sediment except the silt fraction will deposit rapidly on the seabed due to the restricted water circulation in the bay when the breakwaters are in place. Temporary increases in SSC from these fractions will occur only in the immediate vicinity of the barge. The silty fraction of the overspilled material disperses further over Nigg Bay and the entrance channel, causing maximum peak SSCs of up to 250 mg/l in the central area of the bay, but these peaks are very short lived and SSC returns to background concentrations very rapidly, before the next release. Within Nigg Bay, the average SSC is of a very small magnitude, falling to 9 mg/l. Any increases in SSC in Nigg Bay can be anticipated to be within the natural range of variation of SSC in the area (average SSCs measured at Nigg Bay ranged between 144 mg/l and 24 mg/l, with high turbidity events raising SSC to levels of between 529 mg/l and 899 mg/l).

Should these dredging operations in Nigg Bay overlap with maintenance dredging at Aberdeen Harbour, this would result in overspill plumes occurring in both locations simultaneously. Modelling shows that these operations would not result in cumulative increased SSCs in the area, as they will not overlap given the limited spatial extent of each resulting plume.

The MarLIN benchmark used for the assessment of sensitivity and recoverability to this effect is for an acute change in background suspended sediment concentration of 100 mg/l for 1 month. As covered in the physical disturbance section, the dominant subtidal biotope within and outside the EIA boundary is **NcirBat**. This biotope is considered ‘not sensitive’ to increases in SSC while **FfabMag** has ‘very low’ sensitivity (Budd, 2006; Rayment, 2006). **Glap** does not have a sensitivity assessment but the related biotope **MoeVen** has a ‘very low’ sensitivity to increases in SSC (Durkin, 2009). In areas where the sediment is subject to continual disturbance by wave action, **MoeVen** grades into **Glap**, which is more impoverished and lacks the venerid bivalve communities, and therefore **Glap** is assessed here as being even less sensitive to increases in SSC. However, as a precaution it has been assigned the same sensitivity as **MoeVen**. The related biotope complex **SS.SCS.ICS** also lacks a sensitivity assessment but is similarly assessed here as having a very low sensitivity. Following the same reasoning as presented for the physical disturbance assessment **EcCr** is assessed here as having a ‘very low’ sensitivity to increases in SSC. As these five sublittoral biotopes all have very low sensitivity or, in the case of **NcirBat**, are ‘not sensitive’, they are assessed here on block.

Within the context of this ES there is high recoverability and high tolerance coupled with a restricted spatial extent and temporary duration. The frequency with which the impact occurs will be continual for the 19 month period of the dredging activity; however on a day to day basis the intensity experienced at any particular location will vary according to the tidal forces and wave conditions at work. Furthermore, these biotopes will have a wider regional presence as suggested by Figure 12.1, untouched by the proposed development, suggesting broader ecosystem function will be unaffected. Magnitude is therefore assessed as negligible. In terms of value theses biotopes are not valued as Annex I habitats but with the exception of **EcCr** are illustrative of the habitat of principal importance (UK BAP habitat) 'subtidal sands and gravels'. As such they are considered of high value given the national importance of this designation. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

12.7.3.4 Temporary Increases in Sediment Deposition due to Dredging

Increases in sedimentation as a result of the settling of the sediment plume may affect adjacent habitats not directly lost beneath the infrastructure footprint. A temporary increase in sediment deposition rate will occur as sediments that have been disturbed by the dredging operations fall back to the seafloor. As described in Section 12.7.3.3, heavier fractions of the sediment, including sand and gravel, will fall back to the seabed quickly (within seconds for the heaviest particles) and in relatively close proximity to the original disturbance. Finer particles, such as silts and clays, with lower settling velocities, will remain in suspension for longer and will be dispersed over a wider area.

Increases in sedimentation may result in smothering and burial of bottom-dwelling organisms, in particular sessile or sedentary species, as well as modification to sediment habitat as a result of a change in particle size distribution. More mobile species may be able to avoid adverse effects of deposition. Those subjected to burial may have to re-position within the sediment profile to preferred feeding depths. Prolonged burial may also kill any eggs associated with the habitat impairing subsequent recruitment into the local populations. Both smothering and habitat modifications will be temporary, lasting for the duration of the capital dredge only (19 months) and will cease on completion. At this stage natural sediment transport processes such as strong wave and tidal currents are likely to winnow away the finer material with the result that, over time, colonisation pathways re-establish assemblages of benthic invertebrates consistent with the ambient conditions (Tillin, et al 2011). Heavier material is much less likely to be deposited outside of the area being dredged but if this does occur it would require high energy conditions to be displaced and may be a permanent presence going forward. Note that within the harbour where dredging is extensive the impact of sedimentation is not assessed as the original habitat and all species previously associated with it will be lost (see the assessment in Section 12.7.3.1).

The mathematical modelling (ES Appendix 7-D: Sediment Plume Modelling) showed that suspended sediment plumes generated during capital dredging, disposal of dredged material, and other construction operations will spread over a wide area due to the action of waves and currents, before suspended particles settle again on the seabed. Coarser sized particles will settle in close proximity to the disturbance source, while the finer sediment will be transported further away before resettling. The results of sediment plume numerical modelling have informed the assessment of potential effects of the deposition of sediment plumes in the area surrounding the disposal site. No assessment has been carried out of redeposited material in Nigg Bay given that sediment re-suspended as a result of overspill during dredging will be retained within the bay. Any overspilled and settled sediment will be removed by subsequent dredging.

The MarLIN benchmark used for the assessment of sensitivity and recoverability to this effect is for all of the population of a species or an area of a biotope to be smothered by sediment to a depth of 5 cm above the substratum for one month. Outside of the embayment, deposition is only predicted to be very light and certainly much lower than this benchmark. As with increases in SSC, **NcirBat** is 'not sensitive' to smothering from sediment deposition (Budd, 2006). The characterising species are active burrowers and the local hydrodynamics will aid recovery by dispersing finer material (Budd, 2006). **FfabMag** has 'very low' sensitivity with characteristic species unlikely to suffer mortality although some energetic cost will result as feeding and respiration will be impaired and re-positioning necessary (Rayment, 2006). **Glap** is conservatively assessed here as equivalent to **MoeVen** which also has 'very low' sensitivity (Durkin, 2009). **Glap** is an impoverished community subject to continual or periodic sediment disturbance from wave action such that it is considered more transitional in nature and species are therefore, of necessity, robust. In the absence of specific information from MarLIN the **ICS** biotope complex which contains both **Glap** and **MoeVen** is similarly assessed as 'very low' sensitivity. As these four sublittoral biotopes all have very low sensitivity or, in the case of **NcirBat**, are 'not sensitive', they are assessed here on block.

In line with reasoning presented in Section 12.7.3.3, magnitude is assessed as negligible. Similarly, value is assessed as high given the national importance of the 'subtidal sands and gravel' designation associated with the biotopes (Section 12.7.3.3). The significance of the effect on **NcirBat, FfabMag, Glap** and **MoeVen** is therefore assessed as **negligible,** which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

Following the same reasoning as presented for the physical disturbance / SSC assessment, **EcCr** would be assessed here as having a 'moderate' sensitivity to increases in sediment deposition. However, the expression of the **EcCr** biotope here is largely depauperate and sand scoured, dominated by small amounts of dead man's fingers *Alcyonium digitatum*, occasional hydroids and bryozoans and with considerable numbers of common starfish *Asterias rubens* throughout. Dead man's fingers and common starfish have 'low' and 'very low' sensitivity to smothering respectively, and this coupled with the outputs of the modelling, indicate that **EcCr** for Nigg Bay has, at worst, 'low' sensitivity (Budd, 2008a; Budd,2008b). The spatial extent of the impact is restricted, the duration temporary and the frequency, whilst continual, will vary day to day based on tidal cycles and wave conditions and the associated moderating effect these have on the processes. This in combination with the likely wider regional presence of the biotope means that magnitude is assessed here as negligible. **EcCr** is not valued as Annex I habitat Reef and is not protected under any other designation and is assessed as of negligible value. The significance of the effect on **EcCR** is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

In the absence of a sensitivity assessment **Ldig** is, as a precaution, assessed as having a similar assessment as **Ldig.Ldig**, that is 'low' (Hill, 2000). Further information on the rationale behind this is presented in Section 12.7.3.1. **Ldig** encountered in the survey area was both, sand scoured and unstable in places. Spatial extent is limited and the duration will be temporary. The frequency with which the impact occurs will be continual for the 19 months during which the dredging occurs but tidal forces and wave conditions will moderate the intensity experienced at any particular location on a daily basis. The biotope will have a wider regional presence and so magnitude has been assessed as negligible. In terms of value the biotope is common and widespread and for Nigg Bay is not captured by any site designation and as such the value is assessed as negligible. The significance of the effect on **Ldig** is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

12.7.3.5 <u>Temporary Release of Sediment Contaminants due to Dredging</u>

The re-suspension and subsequent dispersion of sediments during capital dredging and construction operations may lead to the release into the water column of any sediment-bound contaminants. This release can occur as a result of the partition into the water column of contaminants adsorbed to sediment particles or due to the release of porewater when the sediment is disturbed, carrying dissolved contaminants or nutrients.

Trace metal concentrations are naturally higher in fine sediments and that spatial patterns of metal distribution in sediment are strongly influenced by the distribution of fine grained particles in the sediment (Cauwet, 1987; Davis, 2004). Organic carbon is known to be one of the key binding phases for metals in sediment (US EPA, 1999). It is also worth noting that sediments with higher organic carbon contents also have the potential to accumulate significant concentrations of hydrocarbons and therefore that fine muddy sediments tend to accumulate hydrocarbons to a greater extent than coarser sandy sediments (Russell et al., 2004).

Particle size analysis of sediments sampled during the sublitoral benthic survey identified very low percentages of mud at all sites sampled ranging from 0% to 6.3% with over 70% of stations containing less than 1%. The five slightly muddier stations (4.7% to 6.3%) were within Nigg Bay (1, 2, 5 and 7) and one site to the north of Aberdeen harbour (Station 10), but sand fractions remained dominant here too. TOC values were similarly consistently low, ranging from 0.08% to 0.25%, reflecting the low mud contents of the sediments. Sediment contaminant samples were taken at ten locations during the benthic subtidal survey in March 2015 (ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey). The levels of all potential contaminants analysed (a range of metals, Tributyl Tin (TBT); Polychlorinated Biphenyls (PCBs) and Polycyclic Aromatic Hydrocarbons (PAHs)) were found to be consistently well below the Marine Scotland Action 1 levels at all stations.

OSPAR (2009a) notes that contamination, '*arising from seabed disturbance is only a risk in heavily contaminated locations*'. As identified by Cefas (2012) the "degree of contamination of sediments clearly plays a very important role in determining the significance of any mobilisation of contaminants from those sediments". The magnitude of the effect is therefore assessed as negligible given the very low levels of contaminants present in the disturbed sediment. None of the biotopes potentially affected are valued as Annex I habitats but some are associated with the habitat of principal importance 'subtidal sands and gravels' and as such value is conservatively assessed as high. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. MarLIN indicate that in a limited number of situations there is insufficient data available against which to make an assessment therefore the uncertainty is assessed as low-medium.

12.7.3.6 Increased Levels of Underwater Noise/Vibration due to Piling, Drilling and Blasting

Based on their strategic review of a relatively limited amount of offshore wind farm monitoring data, Cefas (2009) considered that the potential effects of noise on benthic ecology were of little consequence. The MMO (2014) reported that the effect of seabed vibration on seabed dwelling marine fauna is unknown and noted that understanding the absolute level of vibration would be of limited value without improved understanding of its effect on the relevant marine receptors. As this is currently lacking no assessment of temporary increases in vibration is possible. Sensitivity assessments for noise available for biotopes and individual species at the MarLIN website indicate that the benthic receptors present are, almost without exception, 'not sensitive' to noise or that the effect is not relevant. The one exception is the common limpet which is assessed to have 'low' sensitivity (Hill, 2008). Therefore, no noticeable effects on benthic receptors are anticipated to occur as a result of increased levels of noise due to construction.

Potential effects of noise on fish and shellfish (including crustaceans and cephalopods) have been addressed in ES Chapter 13: Fish and Shellfish Ecology.

12.7.3.7 Accidental Releases of Pollutants During Construction

Accidental spillages or release of chemicals into the environment, such as fuel and oil during the construction phase, could potentially contaminate the marine environment and harm benthic ecology receptors. It is likely that any accidental spillage or release would be, to a greater or lesser degree, dispersed by tidal currents and wave action. As a result any potential effect may be limited. However, static receptors and less mobile species unable to avoid accidental pollution events could experience significant effects.

At this stage, the quantities and types of material that might conceivably enter the marine environment in this way are not known and so scale and magnitude of effects are unquantifiable at present. In the worst case scenario, the potential significance of an accidental spillage would be high, although the likelihood of this occurring would be very low. Accidents are by definition unknown and the uncertainty associated with this effect is, therefore, high.

The magnitude of this impact on benthic ecology receptors depends upon the quantities and nature of the spillage/release, the dilution and dispersal properties of the receiving waters at the time of the incident and the bio-availability of the contaminant to species.

Therefore, there is potential for an effect of Major significance on benthic ecology receptors to occur. However, development of, and adherence to, an environmental management plan including pollution prevention and contingency plans would significantly reduce the likelihood of this effect ever occurring by controlling the storage and handling of potential pollutants and imposing contingency.

In the presence of an environmental management plan, the likelihood of a potentially major effect occurring is extremely unlikely. Risk is therefore judged to be medium. The uncertainty associated with this assessment is low as stringent management controls are commonly in place for other ports and harbours to reduce the likelihood of a significant marine pollution event ever occurring.

12.7.3.8 Offshore disposal of dredged material

The total volume of material to be dredged is 2,300,000 m^3. Although some material may be beneficially used within the development, to represent a realistic worst case scenario, this assessment has assumed that the majority of seabed material arising from the dredging and blasting operations will be transported to a licenced offshore marine disposal site via hopper barge and disposed to the seabed. The dredging activity is currently expected to take 19 months in total and it is assumed that dredging could take place 24/7 and throughout the year. The first 45% of material (i.e. the less consolidated top layers) will be dredged using a trailer suction hopper dredger. The intention would then be for the remainder to be dredged using a backhoe dredger into barges with up to 3 barges will be operating at any one time. The material removed can be disposed of through the bottom opening of the associated barges at a licenced disposal site.

It is anticipated that disposal activity will be most frequent during the two spring/summer construction periods when the greatest quantities will be generated from the capital dredging and blasting operations. In addition, material from maintenance dredging will be disposed on a regular basis during the operation of the scheme.

The movement of the hopper barges between the project and the licenced disposal site is not expected to have any significant adverse consequences for benthic ecology and in addition would not be unusual in the context of the daily vessel movements that already occur in the coastal waters off Aberdeen.

The heavier cobble, boulder and coarse gravel/sand components of the dredged material will settle to the seabed immediately on release from the barge and will be deposited within close proximity to the initial release. The finer components of the material however are expected to remain in suspension for longer and will be dispersed and diluted over a wider area depending on tidal conditions at the time of the release but will mostly settle to the seafloor within a short period of time.

Numerical modelling shows that upon release, the majority of the disposed dredge material (coarser sands and gravels) will settle rapidly to the seafloor in close proximity to the release point (see ES Chapter 7: Marine Water and Sediment Quality). The finer components of the material however will remain in suspension for longer and will be dispersed and diluted over a wider area depending on tidal conditions at the time of the release, but will generally settle to the seafloor within a maximum of 3.25 hours and on the next slack water occasion.

Optical Back Scatter observations recorded peak SSC of between 529 mg/l and 899 mg/l during the metocean campaign within and outside Nigg Bay (ES Appendix 6-A: Oceanographic Works). The current annual maintenance dredging of the existing harbour was considered as part of the baseline, where modelled peak SSC at the disposal site reaches 19,524 mg/l.

For disposal of TSHD dredged material modelled peak SSC at the disposal site is predicted to reach 10,192 mg/l, but these peaks are very-short lived and SSC return to background concentrations very rapidly, before the next release, with average SSC at the disposal site of 300.4 mg/l. Within 0.5 km from the disposal site peak SSC falls to between 872 mg/l and 974 mg/l on each release.

For the backhoe dredger the results are similar to the TSHD, with the model showing that coarser materials (gravels and coarse sand) will settle quickly on the seabed in the disposal area and immediate vicinity. The mud fraction will create the largest plume, with discernible increases in SSC extending up to 11 km along the plume axis. The peak SSC at the disposal site is 4719 mg/l, though dredged material settles quickly, resulting in an average SSC of 308.5 mg/l. Within 2 km from the disposal site peak SSC fall to 207 mg/l to the north and 123 mg mg/l to the south on each release.

Whilst disposal of construction related material will be more frequent than maintenance dredging, the granular material will settle much faster than river silts and muds and produce much lower average SSC levels.

In terms of deposition numerical modelling for TSHD also shows that the medium sand fraction will deposit on the seabed in thicknesses ranging between 1,042 mm and 74 mm over an area elongated in the northeast-southwest direction, up to 0.9 km to each side of the disposal site. An even distribution of all sediment disposed of across the disposal site would result in a seabed level increase of approximately 2.6 m. In reality, this increase will be greater towards the centre of the disposal site and will decrease towards its outer areas. The action of waves and currents will level the seabed at the disposal site over time, smoothing the seabed bathymetry.

Should the disposal of this material overlap with the maintenance dredging operations at the existing Aberdeen Harbour, this will result in cumulative deposits of sediment at the disposal site. The model shows that the cumulative deposition of River Dee maintenance dredged material combined with construction TSHD and backhoe dredged material would lead to a maximum increase in the height of the seabed of approximately 4 m, within the disposal site itself.

Modelling of the baseline disposal of sediments from maintenance dredging at the existing harbour shows that material settles following north-east to south-west pattern. The modelled thickness of deposited sediment at the disposal site is 594 mm, decreasing towards the edges of the area. At 8 km in the north-east and south-west directions, sediment thicknesses are 7 mm and 11 mm respectively.

Numerical modelling for backhoe dredging shows similar results as for THSD in terms of deposition of sediment on the seabed around the disposal site. However, the extent of the area of deposition is larger, given that finer fractions are present in the material disposed of from backhoe dredging (these finer fractions were removed from TSHD disposal material via overspill). These fine sediments deposit on the seabed up to 7 km over an area elongated in the northeast-southwest direction, with a maximum thickness of 45 mm at the disposal site. Coarser fractions settle on the seabed at the disposal site or its immediate vicinity. An even distribution of all sediment disposed of across the disposal site would result in a seabed level increase of approximately 1.3 m, within the disposal site itself.

Cumulative deposition of sediment on the seabed at the disposal site as a result of backhoe dredging and maintenance dredging at Aberdeen Harbour would amount to a layer of settled sediment of approximately 2.4 m thickness. Cumulative deposition of maintenance dredging with TSHD and backhoe dredging combined would lead to a maximum increase in the height of the seabed of approximately 5.3 m, within the disposal site itself. In summary, dredging operations in Nigg Bay and the subsequent disposal of all dredged material at sea (except rock) will result in the deposition of the released sediment at the disposal site in layers up to 2.6 m and 1.3 m for THSD and backhoe dredging respectively, within the disposal site itself. The finer fraction of the disposed sediment will deposit over a wider area of up to 7 km, with the thickness of the deposited layer decreasing from the disposal site to the edges of the area. The action of waves and currents will level the seabed at the disposal site over time, smoothing the seabed bathymetry. These impacts will be reduced should part of the dredged material being reused in construction.

Disposal of dredged material at the disposal site will smother benthic communities leading to a local impoverishment of the habitats affected. Repeated disposal may prolong benthic instability and delay the recovery and restitution of more baseline invertebrate communities. Sedentary/sediment dwelling species within the footprint of the deposit would suffer burial potentially leading to mortality.

As described above, sediment contaminant levels within Nigg Bay were found to be consistently below Marine Scotland Action Level 1 and so adverse toxicity effects are not expected as a result of disposal activity.

Video evidence from within the disposal site suggests there is a limited epifaunal species assemblage present in comparison to a similar site 0.5 km outside of the boundary, to the south. Evidence of infaunal communities was not available.

In conclusion, the impact would be long term, lasting for the duration of the scheme but localised and intermittent. Impact magnitude is thus judged to be minor. Value is assessed as moderate as the habitats in the disposal site are captured by the UK BAP ‘subtidal sands and gravels’ designation, but the disposal site is already subject to periodic disturbance from licenced disposal activity and therefore is likely to be degraded in relation to similar habitat extensively available in the wider region (Figure 12.1). The significance of the effect is therefore assessed as **minor adverse**, which is not significant in EIA terms.

This assessment is associated with high uncertainty as the nature of the seabed habitat and associated benthic receptors within and around the nearest possible disposal site is not well understood (being solely based on video evidence and subject to alteration based on ongoing usage).

12.7.4 Operational Phase

12.7.4.1 <u>Introduction of New Seabed Habitat and Colonisation by Non-Native Species</u>

The presence of new hard infrastructure represents a change from existing conditions. The source of most colonization of this infrastructure will be from the natural hard substrate already present in the wider area, examples of which are provided in the site specific report (ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey and ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey). These communities will be very different to those associated with the previously present soft sediment habitats. The impacts will be long term / permanent lasting for the operational lifetime of the proposed development. Biological succession can result in the establishment of communities similar to those already naturally present in the region; the rate at which this biological succession from colonisation to a more stable established community occurs is influenced by the local physical (e.g. hydrographic regime) and biological conditions (e.g. larval supply).

The subtidal rock communities already present are as outlined in Section 12.6.2.2 and include **EcCr** and **Ldig**. Species associated with these habitats may therefore benefit from the presence of new hard substrate where the conditions support their establishment, and any maintenance activities required on a year to year basis do not overly disrupt this process. Communities which develop here will have some similarity to those which occur naturally, but the very exposed nature of the new habitat on the external faces of the breakwaters will not enable a simple continuum of biotope type.

Any impact of the introduction of new seabed habitat, leaving aside the question of non-native species, will have a moderate spatial extent and be permanent. The loss of subtidal habitat beneath the proposed development infrastructure was calculated as 25% of the total subtidal area within the EIA boundary. The equivalent amount for the intertidal area was 32%. As the loss has already been considered, this assessment focuses solely on the change to new habitat. The areas of hard substrata gained will be larger than those areas lost due to the three dimensional nature of the new habitat; however, in the context of the wider region this increase is small and it is considered likely that some form of the habitats already present will emerge over time. As such the magnitude is assessed as minor. The value of these habitats is similarly negligible. The significance of the effect is therefore assessed as **negligible,** which is not significant in EIA terms. The uncertainty associated with this assessment is medium as receptor responses are documented, and interactions are understood.

The concern that new hard structures in coastal environments may aid the establishment and spread of non-native species through a ‘stepping stone’ effect for species brought in as larvae by ballast waters or biofouling on ships hulls is indicated in the scientific literature (Glasby et al., 2007; Mineur et al 2012). OSPAR (2009b) state that on, ‘*a regional scale, a high number of artificial hard coastal structures in proximity can act as “stepping stones”, disrupting natural barriers to species distribution and providing new dispersal routes that permit the invasion of non-indigenous species*’. In addition, it is understood that artificial structures are reported to be more suitable for non-native species than natural reefs by changing the competitive interactions (Tyrrell and Byers, 2007). The potential introduction of invasive non-native species could alter ecosystem dynamics. It is relevant to note that floating structures in harbours (e.g. pontoons) are understood to support a greater proportion of fouling non-native species than fixed harbour structures (Glasby et al., 2007; Nall et al., 2015). The proposed harbour expansion at Nigg Bay is composed of the latter.

The development and implementation of ballast water and anti-fouling management plans during the construction and operational phases will help reduce the risk of introducing marine non-native species during the lifetime of the development.

The site specific surveys (ES Appendix 12-A: Intertidal Benthic Ecological Characterisation Survey and ES Appendix 12-B: Subtidal Benthic Ecological Characterisation Survey) did not identify the presence of any non-native species, invasive or otherwise, in the core study area with regard to benthic ecology.

Other artificial hard structures are already present in the area, not least the existing harbour and the associated infrastructure and vessel traffic associated with this. Nevertheless, magnitude is assessed as moderate given the likely increase in vessel traffic and identified ‘stepping stone’ effect to which the proposed development may add. The value of the potentially affected receptors is negligible. The significance of the effect is therefore assessed as **minor adverse**, which is not significant in EIA terms. There is a high degree of uncertainty associated with this assessment as it depends on unpredictable events and therefore the environmental risk is assessed as medium-high.

12.7.4.2 Changes to Hydrodynamic Regime

The hydrodynamic regime within Nigg Bay will be largely altered, with eddy currents formed in the bay under the baseline scenario disappearing when the development is in place (see ES Appendix 6-B: Hydrodynamic Modelling and Coastal Processes Assessment). The current speed inside the development area will be reduced greatly due to the present of the breakwaters, but will be increased around the outer walls of the breakwaters. The effect of these changes on biotopes outside of the development footprint is in part suggested by the results of the sediment depositional characteristics and as such is considered in Sections 12.7.4.4 to 12.7.4.6. Scour effects around the protection material (if used) from locally accelerated near bottoms currents would last for the operational lifespan of the project and would likely be highly localised and limited.

Natural seabed habitat close to the breakwaters will be prone to increased disturbance by wave energy dissipation processes and any associated turbulence from these events compared with baseline conditions, in addition to the increased current speeds. However, wave height increases are predicted to be slight. Of course in the near-field local to the development, the wave climate has been changed greatly. The significant wave height inside the development area is predicted to experience large reductions as a result of the protection afforded by the breakwaters. Near-field water level changes due to the altered hydrodynamics in the operational phase will not affect benthic receptors. Far-field changes were not predicted.

Overall benthic receptors would experience very localised modifications and these receptors and the species present will be widely present regionally. The small spatial extent for the duration of the operational lifetime of the harbour means that the magnitude of the effect is considered negligible. The value of the biotopes affected is conservatively assessed as high. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is medium as receptor responses are documented, and interactions are understood.

12.7.4.3 Temporary Seabed Disturbances Due to Maintenance Dredging and Propeller Wash

Seabed disturbance in the operational phase of the proposed development will be limited in comparison to that experienced during construction. Maintenance dredging will occur and some activity will be necessary over time to ensure the proper and continued functioning of the infrastructure (e.g. replacing parts, potential re-positioning of rock armour). In addition, the vessel traffic may disturb seabed habitats in particular through turbulence created by propeller wash, although this will predominantly affect areas already assessed under habitat loss. The habitats external to the proposed development but adjacent to it will only be marginally affected, with intertidal habitats much less affected by these activities than those in the subtidal.

A full account of the sensitivities of the habitats present in regard to physical disturbance and abrasion in the area has been supplied in the construction phase assessment, Section 12.7.3.1. Any disturbance effect on these biotopes will have a highly restricted spatial extent and very limited temporary duration. The new habitat which occurs within the proposed harbour will be subject to repeated dredging events to maintain the required depth and as such has already been assessed as lost habitat. The frequency with which the effect occurs will also be limited. The biotopes will be present more widely within the region, indicating that any broader ecosystem function will be unaffected. Magnitude is therefore assessed as negligible. As some of the affected biotopes are recognised as part of the 'subtidal sands and gravels' habitat of principal importance, value is assessed as high. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood**.**

12.7.4.4 Temporary Increases in Suspended Sediment Concentrations (SSCs) Due to Maintenance Dredging

Maintenance dredging takes place in the existing Aberdeen Harbour each year to remove the sediment accumulated in the harbour. The amount of material dredged is variable from year to year, depending on the duration and intensity of winter storms. The dredged sediment is disposed of at the existing licensed marine site CR110 offshore of Aberdeen.

During the operational phase of the proposed development, regular maintenance dredging will be required to ensure the required water depths are maintained in the harbour basin and entrance channel. It is intended to dispose of the material dredged at sea, at the existing licensed site currently used by Aberdeen Harbour and proposed for disposal of capital dredging material.

The extent and volume of dredged material arising from these maintenance operations will be significantly smaller than those required during the construction phase. Hence, any impacts arising from these operations are anticipated to be of a significantly smaller magnitude than those occurring during the construction phase and similar to those caused by the current maintenance dredging operations at Aberdeen Harbour. Impacts will occur in an intermittent manner (when maintenance dredging operations take place) and be of shorter duration than those related to the construction phase.

A full account of the sensitivities of the habitats present to increases in SSC has been provided in the construction phase assessment, Section 12.7.3.3.

Recoverability and tolerance are considered to be high and sensitivities will be consequently low. Spatial extent is restricted and the duration temporary. The frequency with which the effect occurs will be limited to the maintenance dredging schedule. The biotopes present have a wider regional presence indicating broader ecosystem function will be unaffected. Magnitude is therefore assessed as negligible. Value is assessed as high given that some of the biotopes affected are illustrative of the habitat of principal importance (UK BAP habitat) 'subtidal sands and gravels' which is a designation of national importance. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

12.7.4.5 Temporary Increases in Sediment Deposition Due to Maintenance Dredging

The sediment disturbed during maintenance dredging operations will be dispersed over a wider area due to wave and current action, before resettling on the seabed. The volume of dredged material will be significantly smaller than that required during the construction phase, resulting in a smaller sediment plume and dispersion area, further reduced by the presence of the breakwaters in the case of the plume generated in the dredging area. A full account of the sensitivities of the biotopes present to increases in sediment deposition has been presented in the construction phase Section 12.7.3.4. As a source of impact during the operational phase, the levels likely to be encountered will be a fraction of those experienced during the construction phase.

Sensitivities will be low/negligible and the spatial extent highly restricted and of very short duration. No effects on ecosystem function either locally or regionally are predicted. The frequency with which the impact occurs will be in line with the required maintenance dredging schedule and as such will be limited. Magnitude is therefore assessed as negligible. As previously, value is assessed as high given that some of the biotopes affected are illustrative of the habitat of principal importance (UK BAP habitat) 'subtidal sands and gravels' which is a designation of national importance. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. The uncertainty associated with this assessment is low as receptor responses are well studied and the interactions well understood.

12.7.4.6 Temporary Release of Sediment Contaminants Due to Maintenance Dredging

Fine sediments can harbour greater concentrations of contaminants than coarser sands and gravels (Section 12.7.3.5). The sensitivities of the biotopes present to contaminants have been detailed in Section 12.7.3.5. Modelling predicts that as a result of weak wave action and small currents in the harbour, fine sediments brought into the harbour from the local streams and washed off from the coast would likely to be deposited in the harbour. In addition, any fine sediment load associated with seawater entering the harbour during normal tidal cycles has a greater chance of settling out and remaining in the harbour in the more sheltered conditions. Maintenance dredging will remove sediment accumulated over the previous year, therefore it is anticipated that contaminant levels in the sediment will be low given that contaminated sediments tend to be associated with historic industrial pollution (in material that has not been dredged for many years) or recent pollution events (which are rare given the strict controls on potentially polluting activities). This is the situation in the existing Aberdeen Harbour, where analysis of sediment for previous maintenance dredging works have shown sediments to present contaminant levels below the revised Marine Scotland Action Level 1 (Aberdeen Harbour, 2012). Hence, any impacts arising from maintenance dredging within the proposed development are anticipated to be of a smaller magnitude than those occurring during the construction phase, and similar to those caused by the current maintenance dredging operations at Aberdeen Harbour.

Any effect on the biotopes present will have a restricted spatial extent and temporary duration. The frequency with which the effect occurs will be in line with the required maintenance dredging schedule and as such will be limited. All the biotopes identified from survey work will be present more widely within the region suggesting any broader ecosystem function will be unaffected. The magnitude is therefore assessed as negligible. Some of the biotopes are associated with the habitat of principal importance 'subtidal sands and gravels' and as such value is conservatively assessed as high. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. MarLIN indicate that in a limited number of situations there is insufficient data available against which to make an assessment therefore the uncertainty is assessed as low-medium.

12.7.4.7 Increased Levels of Underwater Noise

The impact and effects of noise on benthic receptors has already been covered in Section 12.7.3.6.

Sensitivity assessments for noise, available for biotopes and individual species at the MarLIN website, indicate that the benthic receptors present are, almost without exception, ‘not sensitive’ to noise, or that the effect is not relevant. The one exception is the common limpet which is assessed to have ‘low’ sensitivity (Hill, 2008).

Magnitude is assessed as negligible. None of the biotopes are valued as Annex I habitats but some are associated with the habitat of principal importance ‘subtidal sands and gravels’ and as such value is conservatively assessed as high. The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms. Although specific data is relatively limited evidence that impacts are more significant is not suggested therefore uncertainty is assessed as low-medium.

12.7.4.8 Offshore disposal of dredged material

Material from the planned maintenance dredging will be disposed of to a licenced offshore marine disposal site on a regular basis during the operation of the scheme. This activity will be subject to a marine licence from Marine Scotland which will be supported by regular chemical testing of the material to ensure it is suitable for sea disposal.

The extent and volume of dredged material arising from these maintenance operations will be significantly smaller with regard to SSC and sediment deposition than those required during the construction phase. Hence, any impacts arising from these operations are anticipated to be of a significantly smaller magnitude than those occurring during the construction phase and similar to those caused by the current maintenance dredging operations at Aberdeen Harbour. Impacts will occur in an intermittent manner (when maintenance dredging operations take place) and be of shorter duration than those related to the construction phase.

Impacts on the disposal site will therefore be long term, lasting for the duration of the scheme, but intermittent relating to each discrete disposal operation. Sediment contaminant levels within Nigg Bay were found to be below Marine Scotland Action Level 1 and so no adverse toxicity effects are expected as a result of disposal activity, despite the finer nature of the sediments within the proposed harbour post-construction, for the reasons already discussed (in particular within Sections 12.7.3.5 and 12.7.4.6).

Any impacts associated with vessel movements to and from the disposal site are considered to be negligible against the backdrop of the numbers of vessel movements within the area. Impact magnitude is thus judged to be negligible. Value is assessed as moderate as the habitats in the disposal site are captured by the UK BAP ‘subtidal sands and gravels’ designation, but the disposal site will be subject to periodic disturbance from ongoing disposal operations from the existing harbour and therefore is likely to be degraded in relation to similar habitat extensively available in the wider region (Figure 12.1). The significance of the effect is therefore assessed as **negligible**, which is not significant in EIA terms.

This assessment is associated with high uncertainty as the nature of the seabed habitat and associated benthic receptors within and around the nearest possible disposal site is not well understood (being solely based on video evidence and subject to alteration based on ongoing usage).

12.7.5 Mitigation and Residual Effects

The final design and implementation of the mitigation measures will be developed and agreed in consultation with the regulators and stakeholders for subsequent incorporation within the Construction Environmental Management Plan.

The proposed development will remove and alter the current biotopes of Nigg Bay. However, the erection of new hard infrastructures will create areas which can be used for colonisation. In a regional/national context the loss of biotopes present within Nigg Bay is considered highly unlikely to result in any impairment to ecosystem functioning at this scale. Similar habitats are present within the wider area with other artificial hard structures already present.

The development of, and adherence to, an Environmental Management Plan including pollution prevention and contingency plans would significantly reduce the likelihood of an impact ever occurring from an accidental release of pollutants during the construction phase through the controlled storage and handling of potential pollutants.

The development and implementation of ballast water and anti-fouling management plans for construction and maintenance vessels and the operational phase of the proposed development will help reduce the risk of introducing marine non-native species during the lifetime of the proposed development.

With the exception of aspects related to the permanent loss of seabed habitat, the effects on benthic ecology are considered to be of **minor adverse** significance or below, which is not significant in EIA terms, so that receptor specific mitigation measures are not proposed. As part of normal operating procedure Construction and Environmental Management Plans (CEMP) will be in place to control and limit the risk of accidental spillages and introduction of marine invasive non native species occurring so that events that may have major adverse consequences on benthic ecology will be extremely unlikely to happen. This aspect has been incorporated into the main assessment sections. Based on this and given that ecosystem function at a regional/national scale is likely to be unimpaired, residual significance is assessed as being no different to the effect significance as originally assessed.

12.7.6 Cumulative Effects

The developments within the wider area that have been taken into consideration for the assessment of potential cumulative effects are provided in ES Chapter 5: Environmental Impact Assessment Process.

In their EIA scoping opinion response (ES Appendix 1-D) SNH stated in regard to hydro-dynamics, sediments and coastal processes that they, '*do not anticipate any significant connections with developments on adjacent shorelines which would give rise to cumulative impacts*' (AHD 2014). This provided a useful background to the following assessment given the importance of these in structuring marine benthic communities.

As outlined in ES Chapter 5, Section 5.1.2, the developments which have been included within this scope and for which cumulative impacts have been considered are:

- Aberdeen Harbour Maintenance Dredging;
- European Offshore Wind Deployment Centre (consented); and
- Kincardine offshore Wind Farm (in planning).

The European Offshore Wind Deployment Centre is a 7 km^2 licensed area situated 10 km to the north of Nigg Bay with a proposed cable landfall point at Black Dog, north of the Don Estuary. Given the distance between this development and the Aberdeen Harbour Expansion Project, there are not anticipated to be any cumulative impacts on the benthic ecology. Therefore, this section will only discuss the potential cumulative impacts resulting from the Aberdeen Harbour dredging operations and the proposed Kincardine Offshore Wind Farm.

Aberdeen Harbour Maintenance Dredging

The maintenance dredging of Aberdeen Harbour is undertaken on an annual basis. This material is disposed of at AHB's existing licensed sea disposal site (CR110 Dee River) situated approximately 3.5 km south-east of Nigg Bay. AHB currently disposes up to 240,000 m^3 of dredged material at this location each year, normally over a 4 week period in Spring. As a worst case, it is anticipated that the quantity of sediment dredged and subsequently disposed of at this site during the construction phase of the new harbour development would be up to 2.3 million m^3 of sediment, thus increasing the volume of sediment deposited at the licence site by an order of magnitude. Furthermore, there will be annual maintenance dredging at the new harbour, the material from which will also be deposited at the offshore disposal site. The site will not be extended to accommodate the additional material although a wider area of seabed may be affected than at present, including potential spreads of any contaminants. However, it should be borne in mind that much of the coarser fractions of the deposited material will remain within the licenced disposal area, where the seabed is expected to be already degraded and of no conservation importance.

Cumulative increases in SSC may arise from the overlapping of the sediment plumes generated by dredging activities associated with the Aberdeen Harbour Expansion Project, existing maintenance dredging in the mouth of the River Dee, and the installation of offshore wind turbine foundations and power cables for Kincardine Offshore Wind Farm. The extent over which the sediment plumes disperse will depend on the prevalent currents at the time of dredging and the nature and amount of material being dredged.

Capital dredging operations in Nigg Bay will result in a series of localised short lived episodes of increased SSC restricted to Nigg Bay itself. Peak SSC from TSHD overspill is not predicted to exceed 100 mg/l to 200 mg/l north of Girdle Ness, and average plumes are not predicted to extend beyond the mouth of Nigg Bay.

The disposal of the dredged material at the licensed disposal site will also result in intermittent short lived episodes of elevated SSC. However, the spatial extent, maximum and average SSC of plumes caused by construction TSHD and backhoe dredge material disposal are significantly smaller that for the existing baseline of licensed maintenance dredging for the existing harbour.

The characteristics of the disposed sediment and local hydrodynamic regime predicted quick settling times and extremely localised high SSC predicted for coarse sediments for both baseline maintenance dredging and construction dredging individually. This is also the case for modelling cumulative impacts for maintenance and construction dredging combined.

Peak rates were modelled for cumulative TSHD and AHB maintenance disposal, but this is unlikely to have any relevance to real world scenarios as the peak SSC are extremely short-lived events at the point of release, and two vessel would be unlikely to release at the same time. However comparisons between the disposal site and nearby data extract points, and comparisons between peak and average SSCs demonstrates the localised and short-lived nature of these events, even when considered cumulatively.

Peak SSC for cumulative TSHD and AHB at the disposal site was 29,169 mg/l, falling more than an order of magnitude to 2,774 mg/l at 708 m to the north, and to 2,363 mg/l at 886 m to the south. Average SSC was more than 35 times lower at the disposal site, at 813 mg/l. Average SSC falls to 101 mg/l at 463 m to the north and to 106 mg/l at 463 m to the south. These cumulative average levels are within natural background variability less than 0.5 km from the disposal site.

Conservative model outputs predict a maximum combined change in the depth of the seabed of approximately 5.3 m. Whilst this is likely to be an overestimate, model outputs also show that the local hydrodynamic regime will mobilise the deposits, and reform the seabed morphology over the duration of the dredging programme, ensuring the maximum predicted change will be naturally eroded to a lower level over time.

Given that the disposal of dredged sediment has already been assessed as having a minor environmental effect (Section 12.7.4.8) and that the volume of material dredged during the maintenance of the Aberdeen Harbour is relatively low compared to that of the proposed new development, then no significant cumulative effect of Aberdeen Harbour maintenance dredging is expected.

Kincardine Offshore Wind Farm

The Kincardine wind development is situated approximately 12 km to the south-east of Nigg Bay and approximately 8.5 km from the licensed offshore disposal site and construction is planned for 2016/17, thus potentially overlapping the construction period of the proposed new harbour (Atkins, 2014). It will comprise floating turbines, therefore any increased SSCs and associated deposition from the construction activities will be limited to installation of the subsea cables. These impacts are anticipated to be very localised and temporary (Atkins, 2014), however, there is the potential for the timing of operations to overlap with dredging operations for Aberdeen Harbour Expansion Project. In addition, one of the two cable routes proposed for the KOWF lands at Nigg Bay. Installation of the turbine foundations and offshore cables at the EOWDC will disturb up to 428,100 m^3 (23,100 m^3 for foundation installation and 405,000 m^3 for cable laying) of sediment during seabed preparation works. Therefore, there is the potential for cumulative effects from these proposals.

No numerical modelling of SSC arising as a result of the proposed works at the KOWF has been undertaken, given that the ES is in preparation at the time of writing. However, modelling was undertaken to assess impacts from the EOWDC. Results show that localised maximum increases in SSC of 100 mg/l occur as a result of foundation installation works in the wind farm area and the northern side of Girdle Ness. These SSC are however short-lived, and 64 days after installation of all turbines SSC return to 4 to 16 mg/l in the Nigg Bay area and up to 60 mg/l in the northern side of Girdle Ness. SSC as a result of cable installation works reach similar levels of up to 100 mg/l in the EOWDC area, although these are also localised and short term; and SSC in the Nigg Bay area stay within background levels (Vattenfall, 2011). Similar localised increases in SSC can be anticipated from cable laying works for the KOWF given the close proximity of both proposals to Nigg Bay.

The sediment re-suspended during the construction and operational activities of the project will settle back on the seabed in the area surrounding the disposal area. This may result in an overlap with the settling areas of plumes generated by the installation of the power cables should they occur simultaneously.

Due to the fine nature of the sediments suspended by the construction activities at EOWDC it was found there was little potential for measurable deposition of material within the Aberdeen Bay area, but the material would instead become widely dispersed in the offshore environment (Vattenfall, 2011). Similar results can be anticipated from cable laying works at the KOWF should the Nigg Bay cable landing option be selected. Therefore, no significant deposition of material on the seabed as a result of cumulative sediment plumes is anticipated to occur.

As the wind turbines will be situated 12 km from the proposed harbour development, it is considered very unlikely that there will be in combination effects on the seabed within the immediate area of the development. However, there is the potential for there to be wider cumulative impacts to the seabed habitats outwith the immediate area of the project footprint where temporary impacts are anticipated.

The indicative grid connection route that makes landfall at Nigg Bay, also passes on or close to the existing offshore disposal site used by the AHB. As such, there is potential for cumulative seabed interaction, particularly during the cable installation as the plan would likely be to bury the subsea section of cable and thus likely to involve some excavation/trenching and backfilling. The option being considered for the cable to make landfall at Altens (south of Nigg Bay) may involve directional drilling which would potentially result in the additional discharge of cuttings and mud onto the seabed. These operations would potentially cause temporary disturbance to seabed habitat along the cable route, and sediment suspension and re-settlement would occur. These temporary seabed impacts are similar to those which will be incurred during the construction phase of the AHD to the areas adjacent to the main footprint with good potential for recovery. As the decision of the cable route has not been confirmed, any potential cumulative impacts cannot be quantified. Despite the potential for in-combination effects to occur, these are likely to be mainly temporary: the habitats present are of low conservation value and the species present are known to have natural resilience to physical disturbance. Therefore the in-combination effects to the benthos with the Kincardine Wind farm have been assessed as minor. Given that the work scope for the Kincardine Wind Farm has still to be finalised, the uncertainty associated with this assessment is considered moderate.

Overview

It is acknowledged that there is the potential for cumulative effects on benthic ecology. However, there will be no areas of conservation importance impacted by the cumulative footprint and most of the cumulative impacts will be temporary (with the exception of the disposal of dredged material at the licensed site). Overall the cumulative effects on benthic ecology are assessed as being of **minor adverse** significance, which is not significant in EIA terms.

12.8 Summary and Conclusions

Table 12.10 summarises and present the conclusions of the assessment of effects on benthic ecology receptors.

As can be seen, benthic receptors have been assessed as incurring effects of negligible significance, post mitigation, in all areas identified with the notable exception of the permanent loss of seabed habitat which, depending on the specific biotope in question ranges from minor to major adverse (without the possibility of reduction through mitigation).

Accidental spills were identified as having the potential to be of major significance but with the development and adherence to an EMP this was assessed to have negligible residual significance. In addition, cumulative effects were assessed to be of minor adverse significance.

Table 12.10: Summary of effects

Effect	Significance of Effect	Mitigation Proposed	Residual Significance of Effect
Construction			
Permanent loss of seabed habitat	Minor to Major adverse	None	Minor to Major adverse
Temporary physical seabed disturbance	Negligible to Minor adverse	None	Negligible to Minor adverse
Temporary increases in suspended sediment concentrations (SSCs) due to dredging	Negligible	None	Negligible
Temporary increases in sediment deposition due to dredging	Negligible	None	Negligible
Temporary release of sediment contaminants due to dredging	Negligible	None	Negligible
Increased levels of underwater noise / vibration due to piling, drilling and blasting	Negligible	None	Negligible

Table 12.10: Summary of effects continued

Effect	Significance of Effect	Mitigation Proposed	Residual Significance of Effect
Construction			
Accidental spills	Up to Major adverse	Development of, and adherence to, an EMP	Negligible
Disposal of material at the offshore disposal site	Minor adverse	None	Minor adverse
Operation			
Introduction of new seabed habitat and colonisation by non-native species	Negligible to Minor adverse	Development of, and adherence to, relevant protocols	Negligible to Minor adverse
Changes to hydrodynamic regime	Negligible	None	Negligible
Temporary seabed disturbances due to maintenance dredging and prop wash	Negligible	None	Negligible
Temporary increases in suspended sediment concentrations (SSCs) due to maintenance dredging	Negligible	None	Negligible
Temporary increases in sediment deposition due to maintenance dredging	Negligible	None	Negligible
Increased levels of underwater noise	Negligible	None	Negligible
Disposal of maintenance dredge material at the offshore disposal site	Negligible	None	Negligible

12.9 References

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